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THE DEVELOPMENT OF RHODESIA FROM A GEOGRAPHICAL STANDPOINT.

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MY purpose this evening is to survey the geographical conditions of Rhodesia, and to point out how those conditions have influenced the nature, extent, and locality of the development which has been carried out in that country since the incorporation of the British South Africa Company in 1889. It may be convenient if I recall to you in the first place the main geographical features of the country which are to-day well known.

The great central plateau of Central and Southern Africa, which has a normal elevation of from 3000 to 7000 feet above sea-level, is bounded on the east for the greater part of its length by a mountainous and abrupt escarpment running more or less parallel with the coast and at a distance from it of about 150 miles. This plateau extends normally throughout Rhodesia, but the contour of the country has been profoundly affected by the various river systems which traverse it more or less from west to east. These rivers and their tributaries have considerably denuded the plateau on their course to the sea, which they reach in Portuguese territory after passing through deep gorges in the eastern escarpment. The more important of these rivers are the Zambezi and the Limpopo.

Southern Rhodesia, which is bounded on the north by the Zambezi and on the south by the Limpopo, mainly consists of one high plateau occurring as a hog's back, or saddle, between the valleys of these two rivers, but modifications are introduced into the general plan by the rivers Sabi and Nyagadzi and their tributaries. The elevation of this plateau varies from 3500 to 6000 feet. The Sabi rises at a point near Umtali and, running southwards parallel to the main escarpment for a considerable distance until it almost reaches the Limpopo, cuts a deep and wide valley out of the main plateau. The effect is to isolate the eastern or Melsetter portion of the plateau from the high ground lying to the west of the Sabi River, and to convert it into an independent plateau. North of Umtali the Nyagadzi River and its tributaries in their course to the Zambezi isolate in similar fashion, though not nearly to the same extent, the high region of Inyanga.

Northern Rhodesia might be represented as the southern half of a plateau in the form of a somewhat bent saddle separating the waters of the Zambezi from those of the Congo, were it not that the Zambezi and its great tributary, the Luangwa, constitute a deep and practically straight trough which runs north-east for about 650 miles, from Walker's Drift on the Zambezi to a point near Mirongo in the vicinity of the north end of Lake Nyasa. The Zambezi section of this trough constitutes the greater portion of the southern boundary of Northern Rhodesia. The Luangwa section of the trough, like the Sabi River in Southern Rhodesia, has the effect of isolating the eastern portion of the main plateau from the interior. This deep trough, or valley, is one of the most striking features of the geography of Rhodesia. It is bounded on its western side by a very steep and sheer escarpment, termed in places the Muchinga, varying in height from 1000 to 2000 feet, through which all the tributaries of the Luangwa and Zambezi from the west have cut their way to the valleys below, and pass as roaring torrents through gorges of the wildest character. To the east of this great trough lies the limited area of high land that I term the Fort Jameson Plateau, which separates the valley of the Luangwa from a further valley to the east, running north and south, in which is situated Lake Nyasa. To the west of the trough a tongue of the Tanganyika Plateau, grooved and furrowed by the Kafue River and its tributaries, extends southwards and forms a subsidiary saddle between the Zambezi and Luangwa Valleys. The southern end of this saddle is known as the Batoka Plateau. The average elevation of the central plateau of Northern Rhodesia is somewhat higher than that of the corresponding region in Southern Rhodesia.

The greater portion of the territory lying to the extreme north is on the highest portion of the Congo-Zambezi saddle, in the country known as the Tanganyika Plateau. A comparatively small section of country to the north-east in the vicinity of Lake Tanganyika lies on the Congo side of the divide, and forms part of the upper slopes of the Congo Basin. In this region occur the upper waters of the Luapula and Lakes Bangweulu and Mweru. It is isolated to a considerable extent from the remainder of Rhodesia by a tongue of Belgian territory.

In order to convey some idea of the relative extent of the high and low ground, the accompanying map has been prepared from the best data available. It divides Rhodesia into three zones, which are distinguished from one another by their altitude above sea-level. The regions of highest altitude are taken as comprising all portions of the territory with an altitude of 3500 feet or more. Regions of lowest altitude comprise those portions of the territory with an altitude of less than 2500 feet. The intermediate regions have an altitude of from 2500 to 3500 feet.

With regard to climate it must be remembered that Rhodesia lies wholly within the tropics, and that the extent to which it can be considered to be a white man's country is largely conditioned by considerations of

altitude. I have already shown you that the altitudes differ considerably in different districts, and it is consequently not possible to speak of the climate in general terms which are applicable to the whole country. The conditions experienced in the trough of the Zambezi and Luangwa valleys, and in the neighbourhood of Lake Bangweulu, are wholly dissimilar to those met with on the plateaux where European settlement is taking place. On these plateaux, both in Southern and Northern Rhodesia, the climate is delightful. The days are sunny and the nights are cool. In winter one often suffers from cold, while in the summer the occurrence of the rains tempers the sun's heat. As one passes from south to north, and the sun's rays become more powerful, a greater altitude is needed to establish similar conditions. It may, however, be said with confidence that the experience of Rhodesia so far as it goes is that, given reasonable precautions against malaria, Europeans can work, thrive, and bring up healthy children at comparatively low altitudes, certainly in Southern Rhodesia, at an altitude of less than 3500 feet. I am aware from past controversies in this room that in expressing this view I am treading on dangerous ground. I have, however, the strong support for it of the most competent authorities in Rhodesia, and feel bound to place it on record.

The rainfall throughout Southern Rhodesia is seasonal, by far the greater portion of the rains falling between the end of November and the end of February. From the end of March to the middle of August rain practically never falls, but there are usually light showers in the course of August or September. October is usually dry. The southern portion of Northern Rhodesia exhibits conditions generally similar to those met with in Southern Rhodesia, but as the Congo watershed is approached the seasonal character of the rainfall is subject to local variations.

I exhibit with some diffidence a map which shows the distribution of rainfall throughout Rhodesia in an assumed average year (*Map*). Rainfall maps are proverbially inaccurate, and I cannot claim exceptional virtues for this one. The most I can say is that it has been compiled from the best data which are at present available. In Southern Rhodesia meteorological stations are rare, and records have not extended over sufficiently long periods to admit of accurate conclusions. The records which we possess have been largely due to the scientific work of the Jesuit Fathers, notably of Father Goetz. In Northern Rhodesia still fewer records have been kept, and for this portion of my map I am indebted mainly to a map published many years ago by Sir Harry Johnston, whose conclusions you will be glad to learn have been substantially confirmed by later observations.

One effect of the distribution of rainfall in Southern Rhodesia and its marked seasonal character is that, west of a line which roughly coincides with the artificial boundary which separates Matabeleland from Mashonaland, the rivers in normal seasons are not perennial. In the dry season they usually shrink to a series of pools separated by stretches of sand or

rocks. In Mashonaland practically all the rivers carry running water throughout the year. The irrigation possibilities of Rhodesia cannot be compared with those possessed by countries such as India and Egypt; but this statement must not be taken to imply that these possibilities are negligible. On the contrary, the investigations which have already been made show that at various places in Southern Rhodesia important irrigation projects can be carried out, and that with the aid of reservoirs very considerable areas can be placed under irrigation. The marked seasonal character of the rainfall in Southern Rhodesia and the contour of the country lead also to the belief that a large number of small irrigation projects will be carried out by individual farmers or by associations of farmers. Having regard to the value and extent of the production which experience elsewhere has shown to result from the scientific cultivation of irrigated areas, the fact that irrigation possibilities, which in the aggregate are considerable, exist in the more elevated regions of the territory must necessarily have an important bearing upon the future production and wealth of the country. The great river valleys, notably the Zambezi, Sabi, and Kafue, also present great possibilities in certain districts. Unfortunately, the annual flooding which extends for miles in the region of the Zambezi known as the Barotse Valley, and on the middle Kafue, is not accompanied by any appreciable deposit of fertilizing silt, I presume because, owing to the topographical features of the Zambezi-Congo divide, no considerable denudation is taking place in that region.

Rhodesia is on the whole a well-wooded country and compares very favourably in this respect with the Union of South Africa, but none of its forests in the least resemble the dense evergreen forests which are met with in the coastal regions of the Cape Colony and Natal. The Rhodesian forests are generally of an open character of the Savannah type. Very large areas are covered by scrub, and in certain districts forest trees are met with, notably in Southern Rhodesia in the regions lying to the north and north-west of Bulawayo, and on the slopes of the more mountainous regions of the territory. In Northern Rhodesia very large areas of scrub are also met with, the true forests mainly occurring in the vicinity of the Luangwa Valley and the Congo divide. Partly because of the somewhat inaccessible districts in which large timber trees occur, and partly because there is at present little demand in Europe for the heavy hard woods which the majority of these trees produce, the forest areas of Rhodesia have not up to the present been cut for export on any appreciable scale. They have, however, been of the utmost value for the supply of fuel and mining timber. The forests in the neighbourhood of the Igusi, Khami, Gwaai, and Shangani Rivers furnish the so-called Rhodesian Teak and Rhodesian Mahogany woods, which are much esteemed locally for building purposes and for furniture. They are also being used on a large scale for railway sleepers. A valuable redwood is cut in the forests of the same region, which is conspicuous for immense tracts of deep sand. The trees in consequence

THE SHAMVA DISTRICT, MASHONALAND.

Phot. by Messrs. Strachan & Co., Salisbury.

THE SOURCE OF THE ZAMBEZI.

Negative by Mr. J. C. de Josselin de Jong.

are able to extend their root-systems to great depths and are thus in a better position to resist droughts. Unfortunately the prevalence of veld fires, which are difficult to control in these sparsely populated regions, has had a prejudicial effect upon many of the trees. A very full and interesting account of the forests of Southern Rhodesia is contained in Reports by Mr. James Sim, F.H.A.S., of the Forestry Department of the Union of South Africa, which have been published by the Department of Agriculture of Southern Rhodesia (Bulletin No. 71). Much less information is at present available in regard to the forest areas of Northern Rhodesia, which can obviously have little value from a timber point of view for many years to come. It may be interesting to state that the greater portion of the Barotse Valley region is practically destitute of trees, and that the natives in that area experience great difficulty in procuring timber for their canoes and buildings.

The presence of the tsetse fly constitutes in our present state of knowledge one of the greatest obstacles to the development of vast areas. While Southern Rhodesia is infested by this pest only over limited and isolated patches in the vicinity of the Zambezi Valley, its occurrence in the territory of Mozambique to the east makes transport by draught animals between that region and Rhodesia both difficult and expensive. A belt of fly is similarly interposed between the Fort Jameson Plateau in Northern Rhodesia and the regions to the east. In Northern Rhodesia, as you will notice, fly is very prevalent, though fortunately some of the best agricultural and stock-raising land in the territory is wholly free from it, notably the Barotse Valley, the middle Kafue Valley, and the Tanganyika and Batoka Plateaux.

I do not propose to venture upon any account of the geology of Rhodesia. So far as Southern Rhodesia is concerned a considerable body of literature exists upon this subject. The main features of the country have been dealt with very fully by local observers—notably by Mr. Mennell, Mr. Molyneux, and Mr. Maufe—and high authorities such as Prof. Lamplugh and Prof. Gregory have visited the country and recorded their views. Valuable conclusions in regard to it have also been stated in the papers recently contributed to this Society's *Journal* by Mr. C. O. Thiele as the result of investigations carried out in the neighbouring territory of the Companhia de Mozambique. The principal formations are the granite, the schists, and banded ironstones in which most of the gold occurrences are found, and the forest sandstones which contain the coal-measures and in which small finds of diamonds have been made. Of the geology of Northern Rhodesia we know less, though it may be said that over wide areas visited by Mr. Molyneux, notably in the regions abutting upon the middle course of the Zambezi, the physical conditions closely resemble those which occur in Southern Rhodesia to the south of the river. Northern Rhodesia, however, still offers a wide field for original geological research. Both in Northern and Southern Rhodesia hot mineral springs are met with,

notably near Fort Jameson, in the region of the lower Kafue, and in the Melsetter District.

As geographers I am sure you will be glad to be reminded that from the strictly scientific side the British South Africa Company has not been remiss. Partly from a desire to promote an important scientific object, but largely as the consequence of the persistence of the late Sir David Gill, the Administration of Rhodesia contributed handsomely both assistance and funds to the work of the Geodetic Survey, which has been carried from Inugu south of Bulawayo in Southern Rhodesia to Mpanga in Northern Rhodesia, a short distance south of Lake Tanganyika.

On the last occasion when I was present in this room I had the pleasure of hearing a most instructive paper by Sir Thomas Holdich on international boundaries. My main regret then was that Sir T. Holdich had not been concerned with the delimitation and demarcation of the boundaries of Rhodesia. Few territories have been worse mangled through want of proper geographical knowledge. Its boundaries, so far as I can understand, have every conceivable fault. They impede development and they promote controversy. Look, for instance, at the Caprivi strip—a boundary now in course of rectification—which gave Germany access to the navigable waters of the Zambezi just at a point where, as I shall show you presently, those waters are most emphatically not navigable. Look also at the western boundary of Barotseland—a straight line which ruthlessly cuts in half the well-ascertained limits of the Barotse area. I hope that in time our diplomatists may be equal to repairing the ravages of their predecessors.

The means of communication with the outer world which Rhodesia had in 1889 will next be considered. The Cape railway system ended at Kimberley, and the Transvaal system had reached Pretoria, but no through road north from Pretoria had been established at that time. The only practical route was the road or track followed by traders and hunters which traversed the deep sands of Bechuanaland to Khama's country and extended from there to the north. A branch of this road to the west, known as the Panda-ma-Tenka road, reached the Victoria Falls. The swamps near Fontesvilla in the vicinity of Beira, the character of the country inland, and the occurrence of tsetse fly effectually barred at this time any communication between Beira and Mashonaland. Communication by river with the east coast was also, and still remains, impracticable.

Rhodesia at this period was in native occupation. A few European missionaries and traders were established there, and the country had been visited by explorers and hunters, notably by Livingstone, Baynes, and Selous, but the knowledge available in regard to the resources of Southern Rhodesia especially was extremely limited. The only wealth of the natives was their cattle. Gold and other minerals were believed to occur, but it is obvious that the difficulties in the way of development of permanent and payable industries were enormous. The Pioneer Column entered the country in 1890 by the Tuli Drift on the Limpopo, and made

what is known as the Column Road, which reaches Salisbury *viâ* Victoria and Charter. Mashonaland was then occupied by the Company, but the peaceful development of Southern Rhodesia as a whole only became possible with the defeat and death of Lobengula in 1894, and the suppression of the Matabele and Mashona Rebellions in 1896 and 1897. Up to that time no railway had reached the country; but owing to the early realization by Cecil Rhodes that railway communication with the sea was an essential preliminary to any serious development, the line from Kimberley was rapidly approaching the Southern border in 1897, and a line from Beira was nearing the Portuguese Border in the neighbourhood of Umtali. The extent of the railway development of which these lines to-day form part is shown in the map (following p. 368), in which you will notice that the general trend of the railways running to the north is north-east, and that they run more or less parallel with the east coast. I have often thought that the explanation of this fact lies in the distribution of rainfall which tends to become less as the interior is approached. Consequently the innermost lines tend to be confined within the regions which are more or less well watered. Where valuable discoveries of minerals are made, and as civilization advances, the provision of artificial water supplies becomes practicable, and the tendency to which I refer will be less noticeable. You will observe that the Rhodesian line through the Bechuanaland Protectorate is at a considerable distance from the coast, owing to a bulge in the coast-line, which may possibly account for the exceptionally low rainfall in these regions.

This map also illustrates the manner in which the lay-out of the Rhodesian system has been materially affected by geographical conditions. In a new country railways, for financial reasons, have a habit of following the lines of least resistance. Expensive construction has to be avoided because distances are great and centres of traffic rare. It is generally cheaper at the outset to run a line for a long distance inexpensively than to undertake heavy work over a shorter distance. Tunnels, deep cuttings, and big bridges are only constructed in case of absolute necessity. It follows, therefore, that districts which require heavy work to reach them are apt to be neglected unless their immediate prospects are exceptionally attractive from a railway point of view. As the result of these conditions you will notice that some of the best districts in Rhodesia from a stock-raising and agricultural point of view are still without railway connection with the coast. I refer to the Melsetter, Inyanga, Fort Jameson, and Tanganyika Plateaux. Up to the present no important discovery of minerals has been made in any of these districts, while their agricultural land is somewhat limited in area. Note also the absence of direct railway connection between Salisbury and the Kafue. The indirect route between these points extends over about 900 miles instead of only 300 to 400 miles. But the trough of the Zambezi presents many engineering obstacles, with the result that the construction of this link has had to be postponed. The total

mileage of the railways which the British South Africa Company has been instrumental in constructing is about 2500 miles, at an approximate cost of £15,000,000.

In the development of a new country questions of transport, which are everywhere important, are all-important, as even enlightened natives fully recognize. Some years ago Lewanika, the great Chief of the Barotse, who died last February, was pressed by an enthusiastic Native Commissioner to encourage his people to grow cotton in the Barotse Valley. His reply was very much to the point: "What is the use? They can't eat it." It is a truism to state that efficient and cheap production, however successful it may be from an experimental point of view, cannot be placed upon a commercial basis in the absence of efficient means of transport. This elementary fact is, however, very frequently overlooked; enthusiasm is apt to outpace discretion, with the inevitable consequence of failure and disappointment.

I do not think that any of us can as yet quite realize the important effect which the petrol motor is gradually exerting upon the conditions of colonial development. In Rhodesia motor bicycles have become quite an ordinary means of transport for district officials and engineers, who fly about the country on them over paths which are often the merest tracks. These machines are to be found in the remotest regions of Northern Rhodesia. The light motor-car is also beginning to be looked upon as quite a necessary part of the outfit of a well-to-do farmer, and is adding enormously to the attractions and amenities of country life. Englishmen and their wives are gregarious animals, and mainly because of this characteristic Cecil Rhodes used often to say that his difficulty throughout Africa was to induce the Englishman to remain on the land. It is a difficulty not unknown in this country. In Africa where farms are generally large, and the distances between neighbours and centres of population proportionately great, the solitariness of farm life is quite naturally a great deterrent to settlers. Some people are constitutionally incapable of facing it; others are nervous about the accidents of life, and quite reasonably so. You can imagine, therefore, the effect which is produced upon settlement by the knowledge that a telephone is within easy distance, and that half an hour's run or less in a car will provide social or business intercourse. The next steps will be the introduction on an extensive scale of the motor tractor and the motor lorry, when the extension of serious agricultural settlement into districts, which at present are too far from a railway to allow of the successful marketing of produce, will become practicable. A service of lorries has lately been established to run over the fly country from Kashitu, about 60 miles north of Broken Hill, to Lake Tanganyika to aid in the supply of our forces in that region.

I will deal next with the commercial activities which have become possible as the result of the company's policy of railway construction, and I may remind you that, at the outset of its career, the British South Africa

Company was heavily handicapped in comparison with other great chartered companies, such as the East India Company, the Hudson Bay Company, and the Niger Company. In addition to the handicap due to the inaccessibility of its territory, it suffered from the disadvantage that there were no trade or other commercial opportunities which could be seized immediately. Everything had to be built up from the beginning. In comparison with the coastal regions of South and Central Africa, Rhodesia was sparsely inhabited by natives low in the scale of civilization, naturally indolent and with few wants. There was no native trade worthy of the name to be developed. The country was not producing on any appreciable scale vegetable or mineral products possessing great value in small bulk, such as precious stones, alluvial gold, rubber, or furs, which could be easily acquired and traded by natives or other unskilled persons. The wealth of Rhodesia has to be won by the application of labour and capital to the soil. It was impossible therefore to make the company even approximately self-supporting from the outset. By slow degrees, and at great cost, it has been brought to the stage at which remunerative industries have been established.

Fortunately, the mineral wealth of the country has proved to be exceptional. The success of the mining industry has given the country its start, and mineral production is likely to remain for some years to come its chief source of wealth. The gold belts actually worked cover a large area, a fact which augurs well for further discoveries. The total value of the gold produced since 1889 has been £32,685,432. The production in 1915 amounted to £3,823,167, bringing Rhodesia to the sixth place in the list of the gold-producing countries of the world. Amongst British possessions it now ranks fourth. In Northern Rhodesia no gold discoveries of importance have as yet been made, though favourable results have been obtained on a small scale in the neighbourhood of Fort Jameson.

Rhodesia possesses in the Wankie coalfield one of the great coalfields of the world. The tonnage available is enormous, and the coal both as a steam-coal and as a coke-producing coal is of exceptionally high quality. Coal has also been met with at other points in the Zambezi and Limpopo Basins, but Wankie is the only place at which it has hitherto been worked commercially.

The chrome iron-ore deposits of Rhodesia, which occur in the Selukwe District of Southern Rhodesia, are also remarkable. Of a world's annual consumption in 1915 of about 120,000 tons Rhodesia produced 60,000 tons or 50 per cent. of the whole. The Selukwe district also contains important deposits of asbestos, which is being worked on an increasing scale. The mines in Northern Rhodesia have hitherto been of less importance, and its mineral wealth so far as at present known appears to consist mainly of deposits of zinc, lead, and copper, some of which are expected to prove of considerable value. It is worthy of note that the Victoria and the Gonya Falls on the Upper Zambezi, and the falls of the Kafue, Lusenfwa, and

other rivers which descend from the central plateau into the Zambezi-Luangwa trough, will at some future time doubtless be utilized for the development of metallurgical and other industries.

The stock-raising, agricultural, and horticultural industries of Rhodesia have hitherto been mainly confined to regions situated on the plateaux at an altitude of not less than 3500 feet. Nothing has as yet been done to develop those portions of the territory which, owing to their low elevation, possess a more tropical climate. Agricultural development is moreover, for the present for obvious reasons, practically confined to districts which are situated not more than 25 miles from a railway. Stock-farmers can, of course, go further afield.

Both Northern and Southern Rhodesia are first-rate stock countries, but the extent of the areas in Northern Rhodesia suited for stock-raising is necessarily limited by the distribution of the tsetse fly. Fortunately the Barotse Valley on the Upper Zambezi and the Middle Kafue are both free from fly, and are capable of carrying very large herds. In Southern Rhodesia the best cattle districts for ranching purposes are to be found in Matabeleland, which in Lobengula's time was heavily stocked. Mashonaland is also a good cattle country, but owing to its higher rainfall it is generally more suitable for the fattening of stock and dairying than for ranching.

The chief grain centres of the territory occur in Southern Rhodesia in the vicinity of Salisbury, notably on the Gwebi Flats and in the Mazoe Valley, and in the Victoria District. In Northern Rhodesia the best grain districts are to be found in the Kafue neighbourhood. Maize is the staple crop grown by Europeans, but rice and various varieties of millet are produced in great quantities by native cultivators. Ground-nuts and sunflower-seeds are beginning to be produced on an increasing scale for the manufacture of oil. Tobacco grows everywhere, but its success from a commercial standpoint entirely depends on cost of production. Its prospects in Mashonaland and in the vicinity of Fort Jameson are encouraging. It is probable also that in a few years' time Southern Rhodesia will export citrus fruits on a large scale to Europe. Apples have been tried with varying success, and may in time succeed in the vicinity of Inyanga.

Owing to the distances which intervene between Rhodesia and the markets of the Union, Rhodesia has already been compelled to face the problem of export, and to promote co-operation between producers with this object. A large tonnage of maize has already been exported. Considerable quantities of tobacco have been sold on the London market, and experimental shipments of oranges have been made successfully. The export of meat and other cattle-products is receiving attention, and I look forward with confidence to the day when Rhodesian chilled meat will be exported to this country *viâ* one of the West Coast ports. But before this can occur large herds must be built up and the standard of local cattle improved. This will take time, but meanwhile there is every

reason to expect that a considerable export of canned meat will take place, and possibly also of dairy products.

So far I have referred only to the possibilities in the more elevated regions. In the future, when the Salisbury Railway reaches the Zambezi, I have little doubt that a number of valuable products of a more tropical character, such as cotton, sugar, sisal and other fibres, rubber, and oil seeds, will be raised by planters in the low-lying regions which abut on the Zambezi and Luangwa rivers and their tributaries.

As regards wild rubber, a number of rubber-producing plants of the genus Landolphia are met with over considerable areas in Northern Rhodesia. They include several species of rubber vines and of bushes which produce root rubber. The quality of rubber produced is excellent, and the payability of the industry depends entirely on the density of distribution of the plants and the costs of transport. The British South Africa Company has established a steam factory at Chambesi, which started work just before the war broke out, but which, owing to the shortage of labour brought about by the military operations on the Northern border, has been temporarily closed down. It had, however, been at work sufficiently long to enable samples of the product to be sent home and to supply data in regard to costs of production. As the result of this preliminary information I can state that the production of rubber is likely to become one of the staple industries of Northern Rhodesia.

It may be convenient at this stage to refer to the possibilities of river transport in Rhodesia, which at present are completely undeveloped. The Zambezi and its great tributaries, the Kafue, the Luangwa, the Eastern and Western Luena Rivers, the Kabompo and the Lungwebungu, comprise between them many hundreds of miles of navigable waterways. Some of these waterways are available throughout the whole year, but others can only be utilized for limited periods. In Southern Rhodesia it is possible that use may eventually be made, as waterways, of short stretches of the Sabi and Limpopo rivers, but the probability is small that either of these streams can ever become an important factor in Rhodesian development.

The Zambezi possesses three main sections which may be generally described as navigable. The stretch of about 70 miles which extends from Sesheke to the mouth of the great gorge below the Victoria Falls comprises many rapids, falls and gorges, and separates the Upper Section from the Middle Section. The Kebrabasa Rapids in Portuguese territory which extend for about 60 miles separate the Middle from the Lower Section.

All the three sections have been thoroughly investigated by competent observers, notably by Major A. K. St. Hill Gibbons and Mr. H. de Laessoe. To Major Gibbons belongs the credit of having, in 1901, successfully ascended the middle section of the river in a steam launch, from the Kebrabasa Rapids to the foot of the gorges below the Victoria Falls.

This exploit was the more remarkable because it was undertaken at the period of lowest river. Mr. de Laessoe descended the middle and lower sections of the river by boat in 1903. The navigation of the lower section, though practicable at all seasons, is carried on with considerable difficulty through channels that constantly shift and are impeded by sandbanks, and the mouth of the river at Chinde offers an uninviting port. It is unlikely, therefore, that commercial connection between the Middle and Lower Sections will be established for many years, seeing that connection by rail around the Kebrabasa Rapids would involve the construction of a railway about 70 miles in length. It is probable, therefore, that any future trade which may arise through the opening up of the middle section of the Zambezi for traffic will pass over the Rhodesian railway system.

The Middle Zambezi, over a continuous distance of 485 miles, can probably be made navigable for steam launches and barges during at least eight months in the year, and perhaps for the whole year. The current of the river is on the whole sluggish in this section, and where rapids occur they are usually the result of obstacles that are capable of removal, and in any event disappear when the level of the river rises after the rains. Wide expanses of country at various points on the banks of the river are known to be valuable from an agricultural point of view, and in places there are reported to be large tracts capable of irrigation.

On the Upper Zambezi and its tributaries many hundreds of miles of waterways can be made available for light flat-bottomed barges at comparatively small cost. On the Zambezi itself 550 miles are navigable. The rivers in the Kasempa district in the extreme north are generally deep, sluggish, and free from obstacles, and their use can be extended over wide areas. The Lungwebungu, one of the larger tributaries, is said to provide 400 miles of waterway, and the Kabompo, another tributary, 150. The Upper Zambezi system alone includes, therefore, 1100 miles of useful waterways. The natives throughout this region are skilled boatmen.

The Kafue, like the Zambezi, is divided into three sections which are completely separated from one another for purposes of commercial navigation by formidable rapids. The lower section comprises a short stretch of only some 30 miles, and constitutes the course of the river in the Zambezi valley proper, after its descent from the Batoka Plateau. For the purpose of navigation the middle section of the river is the most promising. It constitutes a magnificent waterway of about 200 miles, extending west and north-west from the point where the railway crosses it at the edge of the Batoka Plateau. The river is navigable by tugs and barges, and large tonnages of produce or minerals could be handled upon it without difficulty. If suitable river craft were provided, and native trade encouraged, the district would certainly provide an excellent and increasing traffic. It had been decided just before the war to place on this section a powerful stern-wheeler with a draft of two feet when loaded. It was designed to have accommodation for 16

LAKE BANGWEULU.

ON THE LUANGWA RIVER.

TYPICAL COUNTRY IN MATABELELAND.

THE INYANGA MOUNTAINS.

passengers, and to be capable of carrying 40 tons of cargo, and of hauling four lighters each carrying 50 tons. The execution of this project has been postponed, but I trust only temporarily.

In the extreme north the navigable sections of the Luapula in the vicinity of Lake Bangweulu also provide 250 miles of useful waterway, which at the present moment is being utilized with great advantage for the supply of the forces operating near Lake Tanganyika. This route is likely to be valuable for the export of rubber.

The conditions which exist in the Luangwa Valley have been fully described in papers which have been communicated to this Society by Mr. L. A. Wallace, C.M.G., the Administrator of Northern Rhodesia, whose excellent example has stimulated many members of his staff to undertake valuable geographical work on their own account. For knowledge of this region we are also indebted to Sir H. Johnston, Sir Alfred Sharpe, and Mr. Sheffield Neave, and more recently to those brave members of the Sleeping Sickness Commission, under the direction of Dr. Aylmer May, C.M.G., the Principal Medical Officer of Northern Rhodesia, who, at the risk of their lives, have carried out researches which have greatly increased our knowledge of the conditions of occurrence of this terrible disease, and have reassured us so greatly in regard to the danger of its extension.

The development of this valley presents certain special difficulties because of its secluded character. It is bounded on the west throughout its length by a steep and sheer escarpment of from 1000 to 2000 feet in height, through which railways could only be carried to the higher plateaux on that side at widely separated points and at great cost. On its eastern side it is bounded by the high Fort Jameson Plateau, to which access by railway from the valley would also be difficult and costly, and from which there is at present no cheap route to the coast. A rough road, that could be made available for waggon transport, gives access from the lower sections of the valley to the Rhodesian railway system at Broken Hill; but there is some fly upon the road, and only valuable produce can bear the cost of transport to the coast by this route. It may serve a temporary purpose, but it cannot be relied upon for permanent development. If, then, this rich valley is ever to be in a position to export its produce cheaply, it will be necessary either to make use of river transport, or to build a railway up the valley so as to connect it with the Middle Zambezi, the Southern Rhodesian railway system. The outlook for water transport is unfortunately not favourable. The river is not navigable at all during nine months of the year, and while it is probably navigable for three months by light craft going downstream over a distance of 250 miles, it is uncertain if it can ever be used for upstream traffic. Its usefulness as a waterway is accordingly negligible.

From this survey of Rhodesian rivers you will realize that stretches of navigable waterway amounting in the aggregate to approximately 2000

miles may in time be expected to become available for commercial traffic, and to act as important feeders to the Rhodesian railway system. While the efficiency of these waterways as a means of transport is of course not comparable with that of even light railways, it must be remembered that the cost of construction in these remote districts of railways of even the lightest character over this total distance would be not less than £5,000,000. The Middle Zambezi will be linked up with Salisbury and Beira when the line from Salisbury to Sinoia had been extended for a further 172 miles. The Middle Kafue is already connected with the Rhodesian railway system, and the waterways of the Upper Zambezi region can also be connected with it by the construction of a line about 40 miles in length from Livingstone to Katomboros.

I have so far said very little in regard to the inhabitants of Rhodesia. When the British South Africa Company first entered the territory the condition of the native population was in every respect deplorable. Matabeleland was occupied by a branch of the Zulu tribe who had migrated from the south and established themselves in that portion of Southern Rhodesia which, as I have told you, comprises the best pastoral country. Lobengula, the paramount chief, was a despot who, in accordance with the traditions of the Zulu race, and for his own safety, ruled his subjects with a rod of iron. No man's life was safe; witchcraft was freely practised; slavery was an institution; the military spirit of the Matabele warriors was fostered by means of frequent attacks upon the persons and property of the subject tribes, and by raids into the territories of the neighbouring chiefs, of whom Khama, Lewanika and Gungunyana were the most important. The condition of Northern Rhodesia was no better. The western portions were under the rule of Lewanika, who, like Lobengula, governed as an uncontrolled despot. The eastern portions, with the exception of those regions occupied by the Awemba and the Angoni, were inhabited by comparatively unimportant native tribes living for the most part as village communities. Slavery was rampant, and large districts were systematically raided by slave-gathering expeditions headed by Arab slave-dealers from the neighbouring Portuguese and Congo territories. I contrast with these conditions those which exist to-day. In the short period of twenty-five years life to the majority of the native inhabitants of Rhodesia has been given a new meaning and a new outlook. A few figures will, I think, bring home to you more eloquently than words can picture it the improvement which has taken place under the rule of the British South Africa Company. In the year 1898–99, when considerable improvements had already been effected, the native population of Southern Rhodesia was estimated at 413,778. The figure at the close of 1914 was about 750,000. In 1901 they owned 43,926 cattle; the corresponding figure at the end of 1914 was 406,180.

I cannot give you similar figures for Northern Rhodesia, but the increase in population which has taken place since the slave trade has

been suppressed is known to have been considerable. The native population of Northern Rhodesia is to-day approximately 850,000. In regard to the material prosperity of the natives, the figures of Government revenue are most striking. When the Company began its work practically no native revenue could be collected for the simple reason that the natives had no means out of which to pay taxes. Their only wealth was their cattle, and their agricultural production, mainly because there was no market, was not in excess of their own requirements. To-day they are able to dispose of their surplus products, and have also many opportunities of securing remunerative employment. As the result of these conditions the natives of Rhodesia are now able to contribute to the public revenue without the slightest hardship a sum of approximately £350,000 per annum in direct and indirect taxation. The acreage cultivated by natives is steadily increasing, and the marked improvement in their methods of agriculture is very striking. For instance, the use of ploughs instead of hoes is becoming universal in Southern Rhodesia, the substitution being strongly supported by the women—the principal wielders of the hoe. The desire of the natives for education is also a most striking feature and most encouraging to those who like myself believe that the prosperity of a territory is best promoted by utilizing the physical and mental capacities possessed by every one of its inhabitants to the utmost possible extent. One of the lessons of this war is that national welfare demands that the drone, either male or female, should be eliminated, in which event we need have no fear as to our future; for if all who can work are encouraged and educated to work in the directions best suited to their capacities there will be wealth, and to spare, for all. I found upon this belief my greatest hopes for the future of Rhodesia which, as I have shown you, is so richly endowed with resources that require for their full development the organized labour and co-operation of all its inhabitants, both European and native.

The settled areas in Southern Rhodesia have a European population now exceeding 30,000 persons. In Northern Rhodesia the European population is only about 2000, while settlement has been practically confined to three centres in the vicinity respectively of Livingstone, Lusakas, and Fort Jameson.

Of this population I need only say on the present occasion that they are of the stuff of which Empire-makers are made, and that they have always exhibited those virile qualities of courage and endurance without which the special difficulties of a new country cannot be overcome. The numbers of this population are at present small, some 32,000 in all, men, women, and children; but the results to which it has contributed are so striking as to require for their proper understanding a right appreciation of the part played by Europeans in what are primarily native territories; where the part of the European is broadly speaking to organize and supervise labour. Let me give you some figures. The total exports of Rhodesia during the ten years ended 31 December 1914 represented a

value of £25,928,481, and the corresponding value for imports is £30,484,384, showing a total trade during that period only of £56,412,865. The high-water figure was reached in the year preceding the war when the exports from Rhodesia (North and South) amounted to about £4,500,000, and the imports to about £3,500,000, giving a total trade of approximately £8,000,000. A very important fact is that of this total trade at least £6,000,000 took place with Great Britain. Is it not very remarkable that the effect of establishing 32,000 persons in this new territory should have given rise in so short a time to a trade of such dimensions? You will perhaps think it even more remarkable when I tell you that the annual value of the total trade of Great Britain with Germany before the war was about £130,000,000, or only about twenty times as large. Has not this fact a most important bearing on the real value to Great Britain of its territories overseas? On the one hand 30,000 of our own race give us a trade of about £200 annually per head of European population, while 70,000,000 Germans give us only £2 per head. Much of their trade, too, has been deliberately designed to injure us. Facts like these afford much food for reflection. They confirm the view which I have long held that the chief value to Great Britain of its tropical and semi-tropical possessions is not that they supply an outlet for surplus population, but that they provide the trade which enables an increased number of our people to live at home.

In face of what I have told you you may perhaps think that the possibilities in regard to European settlement in Rhodesia are limited. In comparison with Canada and Australia, which are destined to become the home of many millions of our race, it is true that the outlook for Rhodesia in this respect, owing to the conditions which I have described to you, is to some extent restricted. But the realization of these facts does not preclude the expectation that a great and continuous expansion will certainly take place in the numbers of the present European population, with corresponding benefit to the wealth and trade of the Empire. Many years ago, from consideration of the population statistics of Johannesburg, Kimberley, and Rhodesia, I formed the view that every additional native working in the mines means an addition of one person—man, woman, or child—to the European population. The conclusion is of course a rough one, but it is approximately correct. The development of the mineral wealth of Rhodesia has as yet hardly begun, for it is inconceivable that in existing circumstances more than a very small proportion of possible discoveries should have been made. A great mining industry gives indirect support to a large population, and, though many of us may not live to see it, the day will probably come when the iron deposits of Rhodesia which at present are entirely neglected will be worked. The agricultural, pastoral, and planting industries of Rhodesia will also attract to them quite considerable numbers of Europeans, and will specially attract those who for various reasons cannot maintain their health in more inclement regions. I hope that after the war Rhodesia will be able to provide a number of

our brave soldiers with the opportunity of making a fresh start, and of leading active and useful lives in conditions where the handicap of partial disablement or of impaired health will be less felt. That, at any rate, is the desire of the Company, and we shall do our utmost to realize it.

I trust that, in touching upon these important and most interesting questions I have not led you too far from the pleasant paths of geographical science, which, to my mind, has the greatest merit of encouraging its explorers and workers to stray from its high roads and to investigate the countries which they traverse. I also hope that I have succeeded in giving you some idea of the noble edifice which is being raised upon the foundations which were solidly laid by those great Empire builders Cecil Rhodes and Alfred Beit, assisted by many others whose names will ever be held in high honour in Rhodesia. Of the great Master-builders one only remains with us, that great Imperial Statesman—Sir Starr Jameson, the President of the British South Africa Company, who is now rapidly recovering from the effects of his recent severe operation. I am confident that all in this room will rejoice to know that he will shortly be able to resume that labour for the Empire to which his life has been devoted, and will recognize that the work of the British South Africa Company in Rhodesia, to which he has so greatly contributed, has been well and truly done.

Before the paper the PRESIDENT said: I will now ask Mr. Wilson Fox to read his paper on the Development of Rhodesia from a Geographical Standpoint. We all know Mr. Wilson Fox as a member of our Council and as an authority who can speak of Rhodesia from the intimate personal knowledge of many years.

(*Mr. Wilson Fox then read the paper printed above and a discussion followed.*)

Sir CHARLES METCALFE: The many maps that Mr. Wilson Fox has exhibited of Rhodesia this evening show the country very clearly, and I think you will see one of the important points about the country which has made the railway development a little difficult compared with, say, Siberia or India, or that grand country between the Missouri and Mississippi in the United States. Rhodesia is much more what the French call *accidenté*—much more up and down. In going along that portion of the Beira railway which looked so small on the map, from Massikessi up to Umtali, we had to climb 2000 feet in 17 miles. That shows you some of the difficulties. If you go over India you will see great flats stretching for miles and miles. It is the same in Siberia, and the same in the United States, and it gives them a great advantage over our country, because they can have a very much flatter gradient for their railways, which can take longer trains with less power. We have been fortunate in Rhodesia in the matter of waterways. When you go from South Africa, where there are practically no rivers that are navigable, and see the Zambezi, and then the Kafue and the other rivers, it is very refreshing, and you feel that some day they will be great feeders to the whole production and commerce of the country at a very slight cost. As Mr. Wilson Fox was saying, the great feature of the country is that you are in the tropics and yet at a high altitude, that is to say, you are at 3000, 4000, and up to 7000 feet

above the sea; the consequence is your nights are always refreshing and cool during the hottest weather. I happened to be at the Victoria Falls, which is only 3000 feet above the sea, whilst the bridge was building, and I had a maximum and minimum thermometer, and took records all the time, and the hottest temperature at night in all those summer months was 55°. Compare that with what some engineers told me who were examining some coal and iron deposits for us in Rhodesia, that at Pittsburg night after night the temperature in the bedroom was 94°. At Philadelphia it is the same thing, and even in London during August we have all experienced extremely hot nights at times. You never have that in Rhodesia. That makes it extremely healthy, and you find that even children flourish. Mr. Wilson Fox has mentioned the woods which are called teak and mahogany. They are not really teak or mahogany, but they are absolutely like them when the wood is cut and worked up. The train made for the Duke of Connaught was entirely composed of teak from Rhodesia. We have not developed these forests to any extent because they are expensive to work. There are also enormous deposits of coal and iron. We have coal-fields for a thousand miles, the Wankie being the best of them. I have seen one of the seams 50 feet in depth. This coal was tested against the best Welsh steam coal by the Cape Government. They tried six trains, each with 150 tons load, using Wankie coal, and six similar trains and loads with the best Welsh steam coal, and I was told that the Wankie coal came out best in that trial. With all these great advantages we are confident that Rhodesia will become a great country. It will follow the usual course. Gold attracts the first settlers, and then others take up farming with cattle, agriculture, and fruit, and then other industries are started. I think that in four or five years we ought to be able to export cattle. The general increase I found in cattle, deaths and all included, was seven-fold in five years. If you had a million head now you ought to have seven million in five years' time. After that, of course, will come the industrial development for which the country is very well fitted. We are all very grateful to Mr. Wilson Fox for his interesting lecture, and also for the beautiful photographs, many of which I had never seen before.

Sir HARRY JOHNSTON: I think that our lecturer to-night has been too modest in drawing his maps; but no doubt he thought it necessary to stick to the facts of to-day. I only point this out because I showed you a rather differently drawn map of Rhodesia about a year ago, which was accepted by many present without a protest. But there were a few who demurred because it transgressed the boundaries of adjoining countries. I had something to do with the making of the very first maps of Northern Rhodesia, and I found it was a good plan in those days to draw bills for posterity to honour. I had to fight against other ambitious pioneers who wished to secure for their respective countries as much as possible of Central Africa, and I believed in being first in the race as regards maps; because people are very impressionable to printed matter, and if you showed them a map with your projected country on it, they took it as an accepted fact. In the course of 1889 I sketched out my plans on the spot, with the help of Sir Alfred Sharpe, Mr. Alfred Swann, and others. In 1890 I drew a map of what I then called "British Central Africa," studded with towns and with a magnificent system of (projected) railways. In the corner you saw a little notice to the effect that these lines were only projected. Many people did not look in the corner, and they turned aside and gave it up as a bad job if they were Portuguese or Germans. Occasionally there came along a tiresome literal-minded person who canoed along a river and failed to see "Fort Rosebery," "Gladstone," or "Rhodes," or whatever might have been

the town placed in that vicinity, though I usually had notice-boards erected to say they were there. Sometimes, therefore, their existence was denied. But the Imperial Government and the Chartered Company moved ahead very quickly, and it was not long before my ambitious maps became actually true. It is only twenty-six years ago since much of this was projected. Cecil Rhodes did not get seriously to work until about 1891. However, he honoured, as it were, the bills I had drawn against him, and before very long these towns, which in some cases were only represented in 1889 or 1890 by a stout stake with a painted board announcing the name, had become in 1892 or 1902 important places, with real streets and real Government buildings, bazaars, and stores. Fort Rosebery was one of the latest to materialize, and it was a source of some bitterness to Lord Rosebery that the explorers of other nations could not find the town named after him for years after it had been placed on the maps.

As regards the climate of this region, Livingstone remarked, "It really is an Italian climate." There is practically no fault as a rule to be found with the climate over much of Southern and Northern Rhodesia. You can, however, legitimately find fault with the climate of the Lower Zambezi Valley, also great fault with the climate of Equatorial West Africa. In those cases the climate is actually unhealthy to white men or women, and I doubt if any serious white colonization can be attempted there. I equally doubt the same about the Isthmus of Panama. The mosquito netting there may have saved you from germ diseases to a great extent, but it cannot modify the temperature and the humidity in the atmosphere. Of course the great point in Rhodesia is not to fight the climate (which you may describe generally as being perfectly healthy), but the germ diseases. But you cannot work the land scarcely even in South Africa without the partnership of the black man. Although one may say Trans-Zambezia is a country perfectly suited to white colonization, it is almost impossible for certain forms of labour to be undertaken by white men. We must work in those regions of South and Central Africa in partnership with the negro, and unfortunately the negro's arterial system is a reservoir of germs. So long as we can eliminate the connecting agency of the insect bloodsucker, we can get along well enough together; but the great problem is always how to eradicate all the insects and ticks which act as germ-conveying agencies. Mention has been made of the tsetse fly. We know by studying the past of Africa that we can eliminate the tsetse fly by various measures—by clearing away all superfluous growth of vegetation of the bush character. If you keep your grass very low and cut down the underwood of the forests, you go very far towards abolishing the tsetse fly, because it dislikes the wind of all things, and desires to take refuge in coarse vegetation. Another most competent agency on our side is the insect-eating bird; and this is a direction in which I hope the Chartered Company will range itself alongside the latest conclusions of zoological science and do all in its power to influence these 32,000 white men and women towards protecting all the insectivorous birds of the country. There are very few wild birds in Rhodesia that seriously injure man's crops. If there are such, they must be kept under control. But the greater number of the insect-eating birds are man's most valuable allies in eliminating the mosquito, the tick, and the tsetse fly. The Guinea fowl devours the larvæ which the fly deposits in the ground. Even though you may deprive yourself sometimes of a toothsome form of food, the more Guinea fowl you can induce to live in the country the less tsetse fly you will have. Then there are the beautiful white herons, generally styled "egrets." Most forms of white heron, especially the smaller ones, live mainly on flies, but the ignorant, stupid Europeans go about

the country destroying the egrets wherever they can. I have seen many a book on Rhodesia recounting how the traveller came away well stored with aigrettes for the womenfolk who were with him or whom he was going to rejoin. I hope Rhodesia may put in force a system of bird protection.

I should like to say this, in acknowledgment of the many directions in which the Chartered Company has striven to foster knowledge, that they have done a great deal through their administrators to promote the study of native languages. Some years ago I read a report emanating from Brussels at the time the Belgians were taking over the Congo Free State, in which a distinguished Belgian Congo official, who has since figured honourably in the present war, described—obviously only for the reading of Belgians—how admirably organized was officialdom in Northern Rhodesia as regards the acquisition of native languages. He attributed the influences that the officials of this Company have over the natives to the extent to which they master the native languages and got into touch with the native people. I therefore wrote to Mr. Wilson Fox to tell him I was endeavouring to complete a voluminous work on the Bantu languages and that I found the more recondite speech-forms of Northern Rhodesia were almost unknown. I asked if he could send out certain instructions to the men out there asking them to fill up vocabularies for me. Before many months had passed I got in this way a rich harvest of information which will be profoundly interesting to those who attempt to trace the past history of Africa from evidence in language and similarity of customs. This information has also shown the comparative stability of these Bantu languages spoken by comparative savages. For about the same time Dr. Peringuey of the Cape Museum kindly had copied out for me the manuscript vocabularies of Livingstone compiled for the most part between 1849 and 1855, in what we should now call Northern Rhodesia. Livingstone was so far in advance of his time that he wrote according to the best and most accurate phonetic notions of the present day. His vocabularies placed side by side with those sent to me many years afterwards might have been written by the same person and show how very little these forms of native speech have varied in sixty years.

I think we may feel reassured in knowing that so much of Central Africa lies under the direction of the Chartered Company, and of Mr. Wilson Fox in particular. I for one hope that my map shown to you last year may before long be the only correct one as regards the boundaries of Rhodesia, a Rhodesia with direct access to the Atlantic Ocean through the northern part of what has ceased to be "German" South-West Africa.

Mr. F. P. MENNELL: I should like to congratulate Mr. Wilson Fox on the very interesting paper he has presented to us. Some remarks have been made about the number of maps he has produced, and he has shown a great number illustrating various stages of the development of the country. Perhaps as one who is interested very much in the scientific side of geography I might suggest that the Chartered Company should undertake to put on record one very useful piece of information. In these tropical countries so much depends upon altitudes. In Southern Rhodesia we have no facts on which to base any idea as to how much of the country is at different altitudes. I think it would be one of the most useful works that could be performed to publish some sort of contoured map of the country. A good deal has recently been done in the way of mapmaking, I am very glad to say, and I should like to give this hint to the Chartered Company, for more propitious times, that one of the most useful forms of activity they could undertake would be to produce some sort of contoured map of the country. I do not think I wish to say anything more except

to congratulate Mr. Wilson Fox on the very interesting paper and beautiful photographs he has shown this evening.

The PRESIDENT: I will conclude by adding my thanks to those which have already been paid to Mr. Wilson Fox for the lecture he has given us, and I am sure I may include the thanks of the meeting. We must all have appreciated the example which he set in sticking to his text, and avoiding all the temptations to dwell upon other aspects, political or picturesque, of this very interesting region. Rhodesia I think has been fortunate in the first place in its name. It is a great thing to have a name that is at once personal and historical, and recalls its earliest founder. Rhodesia has not been forced to take refuge under one of those names depending on a weathercock which other parts of Africa have had to submit to. Rhodesia has also been fortunate in its early history. In the first place it had at its birth the impulse of the unique energy of its founder Cecil Rhodes, one of the greatest makers of Empire, and in its childhood it has had for its administrators a number of able men, some of whom we have here to-night—men who were not too tightly bound in the swaddling clothes of Downing Street, and were relatively free from the interference of the irresponsible Parliamentary critic. In this way it has, at relatively small cost and trouble to the old country, obtained the prosperity it has already reached. It must be a source of pride to all Englishmen to see that this new country has not only pulled through the various trials it has had in its youth, but that now in the world-tempest in which we live it can look forward to the future with perfect hope and confidence. Great possessions, of course, bring to Imperial States not only privileges but responsibilities, and England can congratulate herself on the fact that in this region we have not only found a new home for Englishmen, but have also given to the native races freedom from the slave trade and from the savage rulers under whom they suffered in olden days. There is another, quite a different proof of the prosperity of Rhodesia, which I have gathered from the newspapers during the last week. I am told that Rhodesian interests have produced one of the longest lawsuits which has ever been known in this country. That is a fact which shows that there must be a great deal of South African gold in process of distribution among a presumably deserving profession in this country, and I congratulate both Rhodesia and the Bar on a singular incident.

I will not detain you for more than a few moments with my personal recollections of Rhodesia. I am ashamed to say I have only been there, not as a "globe-trotter," but as a globe-galloper. I was carried round in the wake of the British Association ten years ago, and I am afraid a great many of my recollections relate to time relatively wasted in sumptuous lunches and much speech-making; but I have some other recollections. I brought back a general picture of the country as an eminently livable and pleasant country, with hills and horizons and rivers and all the outdoor things that make life worth living, including a good climate. In Rhodesia there was none of the tropical aloofness which you feel in the lower parts at least of East Africa. Among individual localities the first I recall is a place that has been mentioned to-night, Umtali. It was like a long straggling English village street, climbing up the slope of pleasant green hills. Then there is Bulawayo, which I dare say has grown a good deal since I was there. Towns grow very quickly in Rhodesia. When I recollect it, it seemed rather a fragment or specimen of a town in making. It had a fine square, and some half-finished streets and one or two shops with plate-glass windows, and a Museum, and a general air of being a little surprised at what it had done already. Nor can one forget the wonderful landscapes of

the Matoppo hills, those abrupt-sided flat-topped granite crags with smaller blocks piled about them. The whole landscape, giving an impression of something weird and large and solemn, is a proper burial-place for the founder of Rhodesia. And in conclusion, even though they have been described over and over again, and word-painting is wasted on them, I must add my humble tribute to the Victoria Falls. There are few of the wonders of the world which, when seen for the first time, do not disappoint; but I rank the Victoria Falls, together with Venice and Constantinople, and the Colorado Cañon, and the snows of Kangchenjunga, among the great sights, which are greater than all descriptions. Niagara, in comparison, is commonplace. It is a monstrous weir surrounded by worksheds and advertisements! The Victoria Falls stand for poetry and romance. They are a world of separate waterfalls, one after another, all of the most intricate beauty, veiled but not concealed in the cloud of spray which feeds the green wilderness which makes the framework of the whole picture. I hope we shall all be able before long to take the trans-Continental railroad across Africa, and spend a happy fortnight at the Victoria Falls. To that consummation I am sure that the lecture we have heard to-night will be a stepping-stone, and once more I thank Mr. Wilson Fox for it.

THE MIDDLE TEES AND ITS TRIBUTARIES: A STUDY IN RIVER DEVELOPMENT.

C. B. Fawcett, B.Litt.

Read at the Afternoon Meeting of the Society, 20 January 1916.

MIDDLE Teesdale is that part of the Pennine slopes which stretches eastward from Stainmore. It is part of the drainage area of the Tees, and is clearly marked off from Upper Teesdale by the high ridge of moorland through which the river breaks at the Eggleston Gap and by the distinct physical characteristics of the Upper Dale. This dale is markedly wider than any of its neighbours. Along a north-south line drawn near Barnard Castle the widths of these dales below the 1000-foot contour-line are—

Weardale	...	...	...	...	from 2 to 3 miles.
Teesdale	...	...	...	...	,, 9 ,, 10 ,,
Swaledale	...	...	...	...	,, 1 ,, 2 ,,

This exceptional width of Teesdale suggests that its development is worthy of study. It is one of the facts that this paper attempts to explain.

The landscapes of the dale are characterized by the intermingling of three principal types of land-form—

(1) First there is a wide, comparatively smooth upland surface. If the valleys were filled up this surface would be that of a plain dipping gently to the east and cutting across the strata at a small angle.

(2) The second group of land forms is the series of wide shallow valleys which are sunk below the upland surface. In the west they occupy the

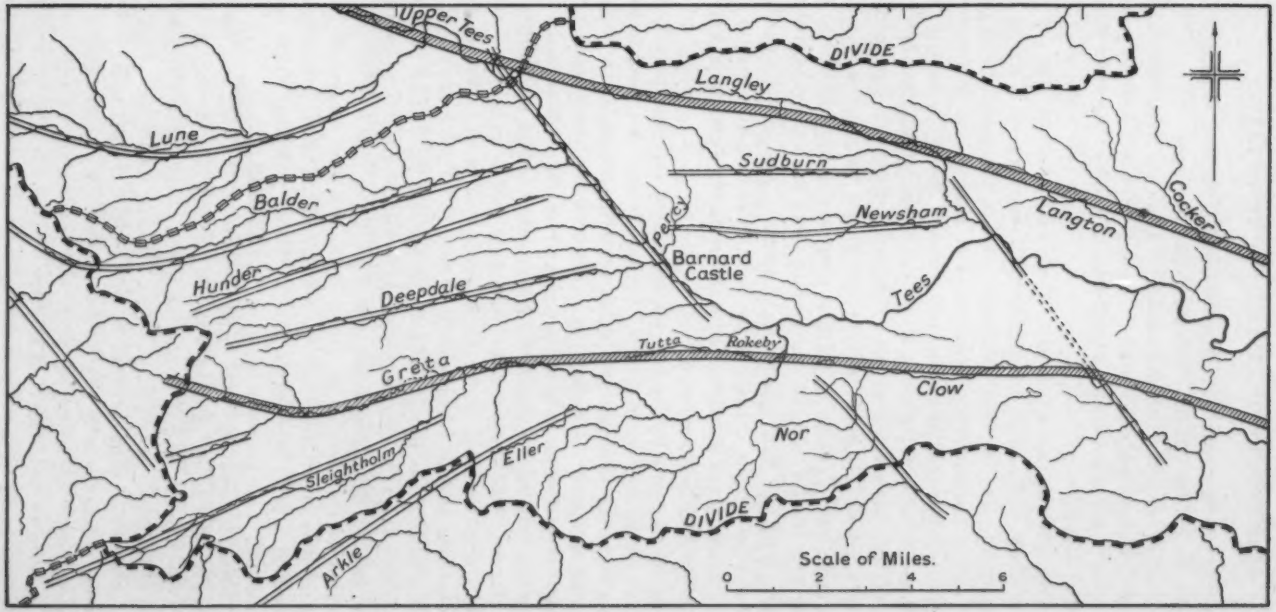


FIG. 1.—STREAMS AND VALLEY-LINES.

The double lines show the valleys, the shaded ones marking the two principal valleys.

smaller part of the area; eastwards they widen out and become more numerous, so that the upland is reduced to narrow ridges.

(3) The third group consists of a number of narrow and steep-sided valleys which often become gorges, in which most of the streams flow for part of their course. These are usually sunk below the floors of the wider valleys referred to above.

Geologically this district is part of the south-western edge of the Durham Basin. Its rocks have generally a small (3°–10°) dip to the north-eastward. In the outer—southern—half of the dale the rocks are mainly Lower Carboniferous limestones and shales; and in the inner —northern—half mainly sandstones and shales of the Millstone Grit and Coal Measures Series. The strata are broken by many faults, lines of weakness associated with which have had a dominant influence on some parts of the stream courses. Most of the fault-lines appear to be referable to one of two main series. Those of the first series are roughly parallel to the Pennine Scar, itself a fault-line scarp, which forms the western edge of the Stainmore and Cross Fell sections of the upland. The second series consists of crescentic faults, concave to the north, stretching from west to east in the southern part of the dale. These are probably related to the Craven Faults of the Central Pennines.

This district was in the track of the great ice-stream which overflowed Stainmore during the Glacial Period; but the ice does not seem to have had any important influence on the stream development, and it caused only minor changes in the topography. The chief result here seems to be the mantle of drift which forms a large part of the soil. Owing to the presence of this drift the Ice Age forms a convenient period in reference to which changes in the streams may be dated.

The general direction of the Upper Tees is towards east-south-east; but on entering Middle Teesdale the river turns to the south-east and flows for over 6 miles in an almost straight trench along the foot of Marwood Scar. This crosses the valleys of several consequent streams at an angle of some 60° with their general direction. In it the Tees receives several tributaries from the west, but no stream of any size from Marwood. This part of the river's course is along a fault-line, and it is nearly parallel to the Pennine Scar, 9 or 10 miles to the west. The few widenings which break the continuity of the gorges in the trench are all small.

At Barnard Castle the Tees bends sharply to the east, and for the next 8 or 9 miles to its junction with the Langley Beck its course forms an arc convex to the south. This is the largest of several such arcs on the streams hereabouts. Along it, as above Barnard Castle, the valley consists of a series of gorges alternating with wider "U" stretches. Of the gorges that at Rokeby is the best known (Fig. 2). It is sunk into an area of massive, almost horizontal limestone, and is much narrower than those in the sandstones and shales. The gorge is at the bottom of a narrow upper valley, on the sides of which are fragments of river terraces. In the

gorges the river receives many small tributaries which fall in from hanging valleys. The "overhang" of these valleys is due directly to the greater eroding power of the Tees as compared with that of their small becks.

At its junction with the Langley the Tees adopts the direction of the lower course of that beck. This is parallel to the lines of the Pennine

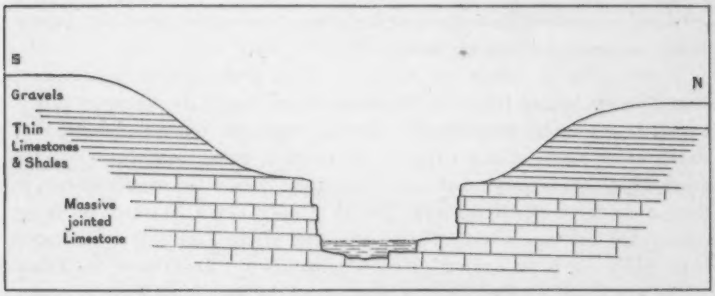


FIG. 2.—DIAGRAMMATIC SECTION ACROSS THE ROKEBY GORGE.

Scar and Marwood Scar further to the west. Like them it is bordered by a steep westward-facing scarp, which may be called Selaby Scar. The heights of these scarps are roughly 1000, 300, and from 50 to 70 feet respectively. All three appear to be fault-line scarps; and probably the faults to which they are due belong to the same series. The general character of this valley of the Middle Tees is illustrated in Fig. 3, which is a generalization of several sections. The three divisions of the surface are traceable in many places along the river, though in no one section are they as complete as they are shown here.

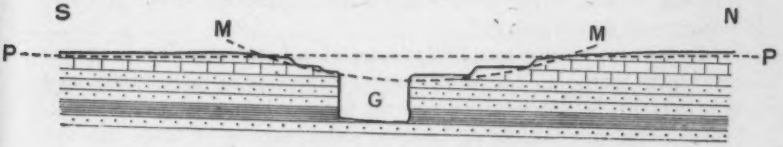


FIG. 3.—GENERALIZED SECTION ACROSS THE TEES.
PP, peneplain surface; MM, mature valley; G, youthful gorge.

The course of the Middle Tees, which has just been described, seems to lie along lines of structural weakness, and it was adopted comparatively late in the river's history. That of its largest tributary, the Greta, on the other hand, is for most of its length along one of the principal valleys of the district; and this has been the course of one of the chief streams throughout the development of this river system.

The Greta rises close to the crest of Stainmore Pass, and thence flows eastward for 8 or 9 miles in a distinctly U-shaped trough. Most of the tributary valleys "hang" over this trough, and their becks enter it by series

of cataracts. Several of these becks are larger than the Greta. Their "overhang" is due to the over-deepening of the main valley, which was the track of the ice-stream over Stainmore. The pass is the notch in which this valley cuts through the crest. About 4 miles east of the pass the slope of the channel suddenly increases, and the river has cut through the thin drift to the underlying rock. This is a massive jointed limestone; and in it the Greta flows underground for some 2 miles, the open-air channel being occupied only during floods.

Some distance below the place at which the Greta reappears it is joined by its largest tributary, the Sleightholm Beck. In the main valley, which it enters by steep rapids, this beck has cut out its channel to a depth which places it below that of the Greta at equal distances above the confluence. This shows that the Sleightholm is now the master stream in that it furnishes the base-level for the Upper Greta, instead of being dominated by that river. The weakening of the Greta thus indicated is probably due to its having lost its headwaters to tributaries of the Eden, a loss which was a factor in the formation of the Stainmore Pass.

East of Bowes, under Kilmond Scar, the valley widens out and the trough form becomes indistinct. Here the Greta leaves the main valley and sweeps southward in a crescentic curve through the Brignal Gorge, which is in places 200 feet deep. Below this the river crosses the main valley at Greta Bridge, and thence plunges northward to the Tees through a steep and narrow gorge barely a mile in length.

Eastward from Kilmond Scar the main valley is occupied by the small Tutta Beck, which is intercepted by the river near Greta Bridge. Further east it is continued as the wide shallow valley occupied by the sluggish stream which is here called the Clow Beck. The relation of the profile of this beck to that of the Greta supports the suggestion that the two were formerly one stream (see Fig. 7).

In this area about Greta Bridge there have been extensive changes in the stream-courses in comparatively recent periods of their history, and the Greta has been three times diverted from its original eastward course. About a mile east of the bridge a broad valley branches off south-eastward. Apparently the Greta was captured along this line, and so diverted to the Swale. The second change was its diversion into the arc from Kilmond Scar to Greta Bridge, a curve similar to the larger arc on the Tees, and probably, like it, determined by fault-lines. Lastly, at a very recent period the river was captured near the bridge by a small tributary of the Tees. These changes and their probable relative order may be summed up as follows (and see Fig. 4):—

The original consequent stream (I.) was first diverted by being captured by a tributary of the Swale, and so turned to the south-east (II.). The maturity of the now-abandoned valley through the moors thus formed indicates that this course was adopted long before the Ice Age; while the presence of recent river deposits in it shows that it was still

occupied for some time after that period. At present its drainage is mainly artificial.

The narrow and very youthful gorge by which the Greta joins the Tees (IV.) is the result of much the latest of these changes. The river has not yet reduced the slope of this part of its course—where, owing to its greater volume and steeper fall, downward erosion is most vigorous —to an equality with the slope in the gorges above. The absence of any obsequent stream at the angle of capture also marks the recency of this capture of the Greta by the Tees.

The course of the Greta in its southward bend (III.) was adopted at some time between the other two changes. The Brignal Gorge is evidently

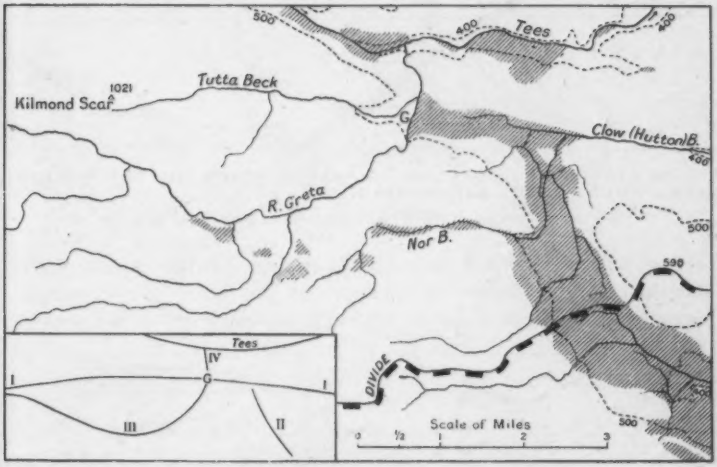


FIG. 4.—STREAMS ABOUT GRETA BRIDGE.

Shading marks areas of recent stream deposits. The "G" marks the site of Greta Bridge. Inset: Diagram of the successive courses of the Greta.

much younger than the abandoned valley to the south-east, and older than the narrower and steeper gorge below the bridge, which is in similar rock. But it is wider and more open than the Rokeby Gorge on the Tees, and is therefore probably older than the latter, for the two are cut in similar rock, and the Tees is here much larger than the Greta. The position of the glacial and river deposits above it shows that the Rokeby Gorge is post-glacial. The distinctly V section of the Brignal Gorge suggests that it too is mainly post-glacial; but the absence of river deposits in the Tutta section of the main valley seems to indicate that the Greta was already flowing along this arc at the close of the Ice Age. The change may have taken place in some interval of the Ice Age.

The second important western tributary is the Balder, the course

of which is roughly parallel to that of the Upper Greta. This river now rises in a marshy col at the crest of the Upland. The streams about this col, the Balderhead Pass, are shown in the diagrams (Fig. 5). A com-

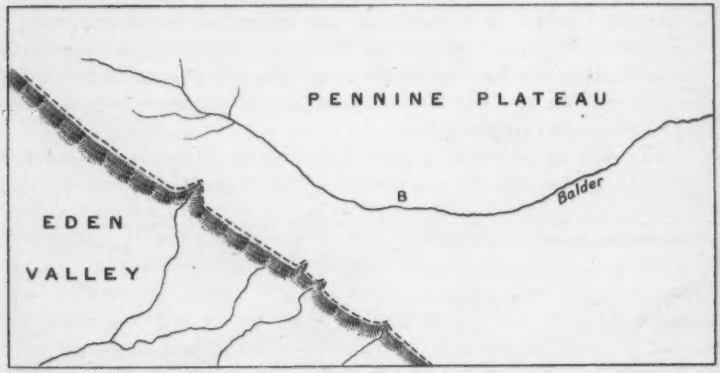


FIG. 5a.—RECONSTRUCTION OF AN EARLY STAGE IN THE STREAM DEVELOPMENT ABOUT BALDERHEAD.

"B" marks the position of the present Balderhead Pass. Compare Fig. 5b.

parison of these shows how the col has been formed by the capture of the headwaters of the Balder by tributaries of the Eden. This eastward migration of the divide is due to the greater eroding power of the streams

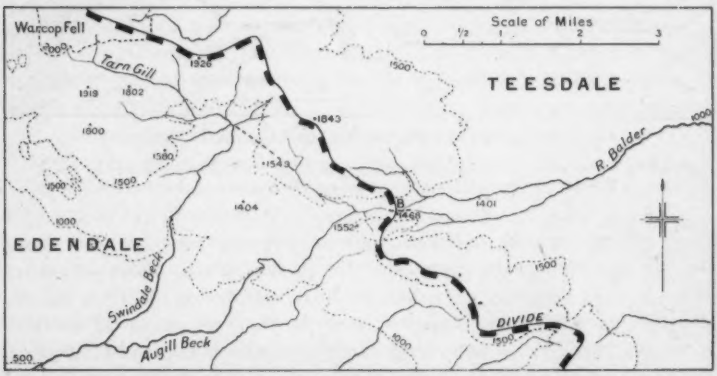


FIG. 5b.—STREAMS ABOUT BALDERHEAD PASS (B). Compare Fig. 5a.

of the steeper and rainier western slope. It is general along the Pennines. It may be noted here that the direction of the Pennine Scar in relation to the slope of the Upland enables the tributaries of the Eden to cut into the valleys of the Upland streams almost at right angles, and so to encroach more rapidly than would be possible otherwise. Other things being equal,

streams which flow away at right angles to a divide have the advantage of gaining more by a slight encroachment than streams whose direction makes a small angle with the divide. None of the other western tributaries need be discussed here. They all repeat a characteristic feature of those already referred to in that their upper courses are in wide open valleys, while their lower reaches are in gorges and are marked by a steeper fall of the stream.

The chief northern tributary of the Middle Tees is the Langley Beck. This rises near the Eggleston Gap, within a mile of the Tees, and flows in an east-south-easterly direction for nearly 12 miles to join the river under Selaby Scar. Langleydale is nearly in line with Upper Teesdale, with

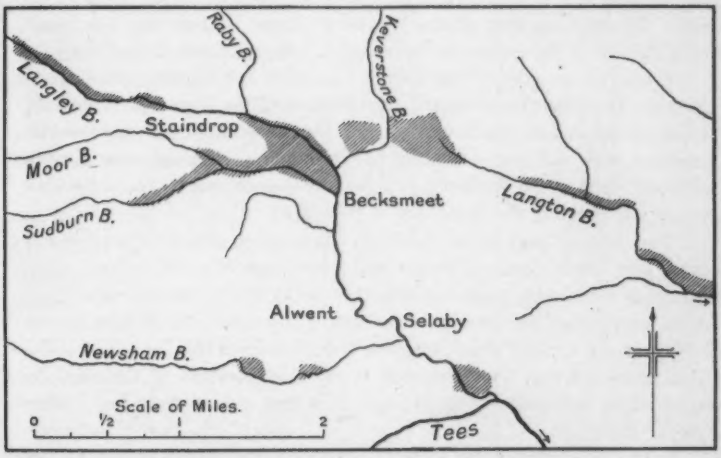


FIG. 6.—STREAMS ABOUT THE STAINDROP PLAINS.
Shading marks areas of recent alluvium.

which it is connected by a slight depression between Marwood and Langleydale Fell. It is an open valley, much wider in proportion to its stream than those already mentioned. Its floor and sides are largely covered with glacial drift, and the beck flows for the most part on the surface of this drift.

At Staindrop the beck enters an area known locally as "The Plains," in which it receives its chief tributaries (Fig. 6). This flat area is surrounded by low hills, except to the east, where a broad valley continues the line of Langleydale. Its soil is mostly alluvium, and it was down to a century ago an area of marsh. The waters which meet here flow out by a gap in the southern rim. This was probably formed in the first instance by a small tributary of the Tees cutting back northward until it reached and intercepted the stream then flowing eastward through the plains.

The present completeness of the drainage is artificial, and all the streams are regulated.

Eastward from the Staindrop Plains the main valley is occupied by the small Langton Beck. The headwaters of this stream are separated from the streams in the plains by a divide so slight that it is overflowed in very wet seasons. Like the Langley, this beck ends by turning southward to the Tees through a comparatively narrow gap. The main valley continues eastward, and is occupied by the Cocker Beck till that stream is intercepted by the River Skerne in Darlington. This northern west-to-east valley of the Langley–Langton–Cocker Becks resembles that of the Greta–Tutta–Clow in the south in its general trend, and in the fact that all the streams in it flow eastward, *i.e.* that it has no obsequent stream of any size. It differs in that all the breaks in it are towards the Tees, while only the last of the breaks in the southern valley is towards that river.

From this account of the stream courses it is clear that there are in Middle Teesdale two principal west-to-east valley lines. The development of these two main valleys and the later union of their waters, together with the less elevation of Stainmore in comparison with the adjacent parts of the Pennines, explains the exceptional width of this dale, which was noted at the beginning of this paper.

The western part of the southern main valley, which is occupied by the Upper Greta, has a general trend a few degrees north of east. This direction is the same as that of the other becks which flow east from Stainmore, except that the uppermost reaches of the Greta and Balder, the two longest, show a curve which suggests radiation from the Cross Fell dome. This east-north-east trend appears to be the direction of the slope on which these streams originated; and it is here regarded as the "consequent" direction.

From the heights to the south of Stainmore the valleys of the Sleightholm and the Arkle–Eller Becks converge upon the southern main valley, with a trend from south-west to north-east. Similarly from Cross Fell to the north the valley of the Harwood Beck and the Upper Tees stretches east-south-east, in the line which is continued by the northern main valley. The confluence which would result from the convergence of the main valleys is anticipated by the development of the oblique transverse valley along Marwood Scar. This takes the Tees from the northern valley across the smaller consequent valleys far enough south to enable it to capture the Greta, and so to bring the waters of both main valleys into a younger valley between them.

The development of this river system and of the complex topography of the district, which is the result of the work of the streams, may be regarded as the resultant of the effects of three distinct cycles of erosion. The three different types of land-forms which make up the topography of the dale are due to the different stages of development reached by these three cycles. The Upland surface is apparently part of the Tertiary pene-

plain of North England, and the few hills which rise above it are remnants of the higher land from which it was formed.

The reasons for holding that the open valleys of the second cycle are pre-glacial have already been stated. Hence the uplift of the older peneplain, which initiated the second cycle, occurred long enough before the Glacial Period to allow of their development. In *The Geological History of the Rivers of East Yorkshire*, Mr. Cowper-Reed has ascribed what seems to be a corresponding uplift in North-East Yorkshire to the latter part of the Tertiary Era, a date which is not inconsistent with the evidence of these valleys, all of which are shallow. The uplift which gave rise to this second cycle was small, and the general direction of the slope was not changed. The convergence of valleys from north and south shows that then, as now, Stainmore was lower than the parts of the Upland to the north and south of it.

The relations of these consequent valleys to the subsequent fault-line valleys are not always clear. At Stainmore Pass the valley opens through the crest. Here it should be noted that this pass is on one of the first of the groups of fault-

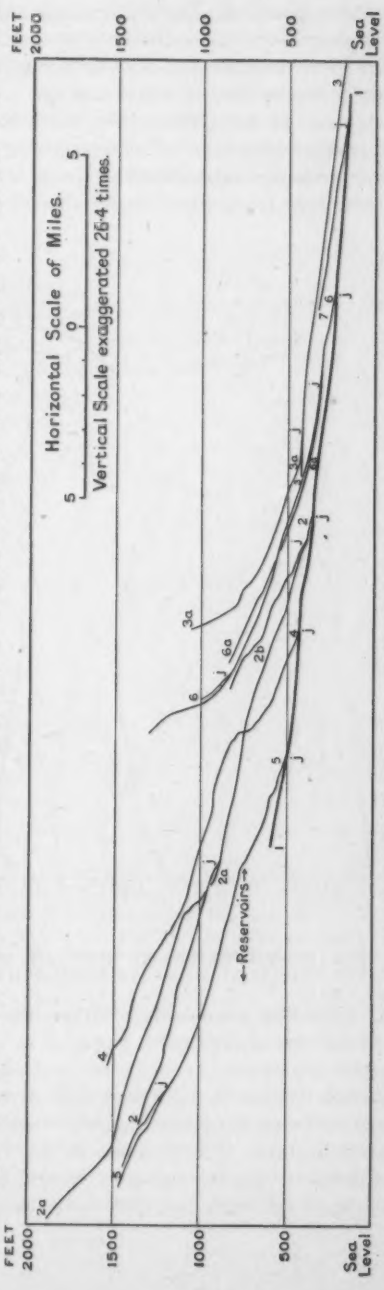


FIG. 7.—PROFILES (LONGITUDINAL SECTIONS) OF THE PRINCIPAL STREAMS.

1, Middle Tees; 2, Greta; 2a, Sleightholm; 2b, Tutta; 3, Clow; 3a, Nor; 4, Deepdale; 5, Balder; 6, Langley; 6a, Sudburn; 7, Langton; j, junction of streams.

lines which branch off eastward from the line of the Pennine Scar. This fact, together with the very active stream erosion, seems sufficient to account for its formation. I have no doubt that stream erosion alone has produced the Balderhead Pass; and the more open Stainmore Pass is probably due to the same agency, aided to a slight extent by the ice in its passage over here. The arrangement of the valley-lines suggests that the two have similar histories.

In the north the size and mature character of Langleydale suggest that

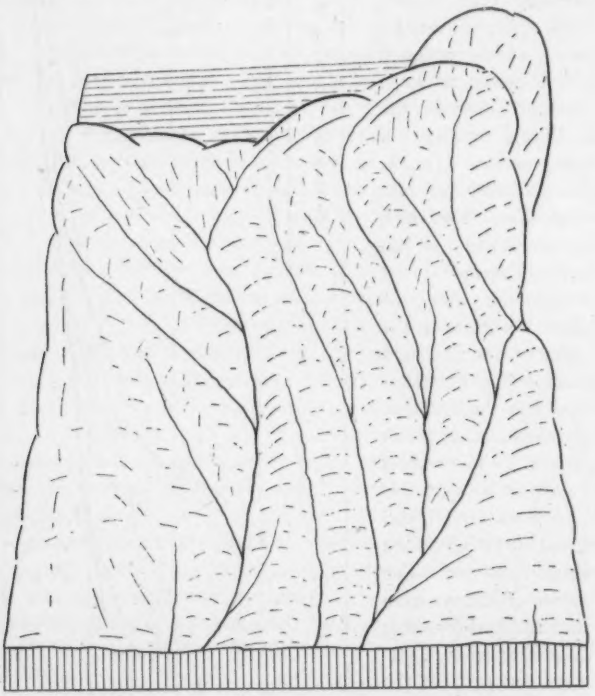


FIG. 8a.—DIAGRAMMATIC VIEW OF MIDDLE TEESDALE IN THE INITIAL STAGE OF ITS DEVELOPMENT (FROM THE EAST).

it was formed by a much larger stream than the present Langley Beck, and so that the waters of the Upper Tees once flowed along it. This suggestion is supported by the character of the Tees valley under Marwood Scar, which is much younger than these second cycle consequent valleys or the Tees valley just above Eggleston Gap, though older than the gorges of the third cycle. The diversion of the Tees from the northern main valley probably occurred late in the second cycle. The first diversion of the Greta, to the south-east, must have taken place early in this second

cycle; and the second diversion probably occurred shortly before its close. The distribution of the glacial drift and its relations to the valleys indicates that the Ice Age caused no important changes in the stream courses. The material of the extensive river terraces was probably accumulated during the melting of the ice, when the valleys were partly silted up.

The third division of the topography is the series of gorges. These are everywhere below the river deposits and the terraces. Hence the third cycle is entirely post-glacial. It is due to a general uplift of the surface,

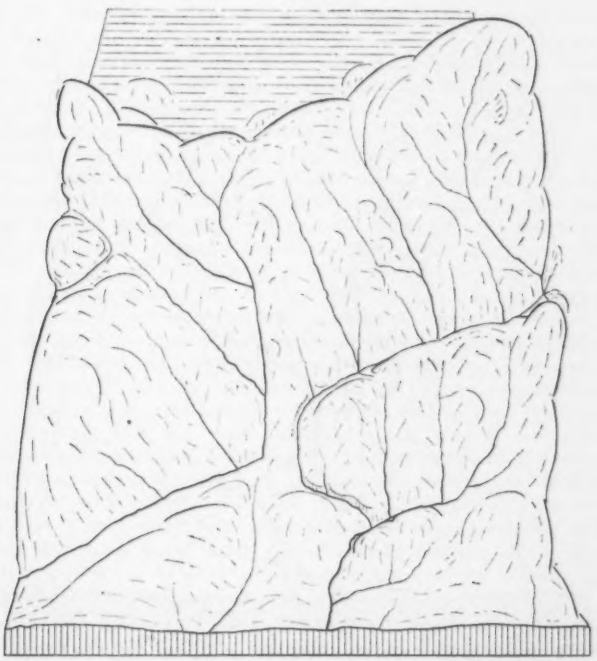


FIG. 8b.—DIAGRAMMATIC VIEW OF MIDDLE TEESDALE LATE IN THE SECOND CYCLE OF ITS DEVELOPMENT (FROM THE EAST).

which closed the second cycle by giving the streams a new base-level. This uplift was quite recent; for this cycle is in a very early stage of its development.

The profiles of these streams (Fig. 7) show in most cases a marked change of slope, in strong contrast to the smooth slope which would normally be produced by uninterrupted stream erosion on a fairly uniform rock surface. In each case the moderate slope is that of the stream in an open valley, and the steep slope that in a gorge. This steepening of slope

and formation of gorges is due to an increase in the power of the streams to deepen their channels. The cause must have been one which affected the whole district. It was probably a general uplift of this part of the country. The deepening of the river beds has not yet affected the upper parts of most of the valleys, which remain in the preceding cycle of development.

On the Greta there are two such changes of slope, and the matter is complicated by the effects of recent capture. The upper change occurs where the river is mainly an underground stream, and is probably due to

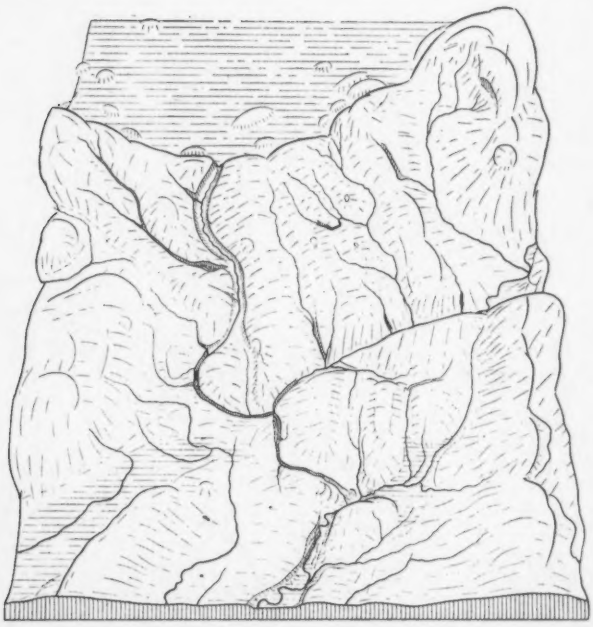


FIG. 8c.—DIAGRAMMATIC VIEW OF MIDDLE TEESDALE IN ITS PRESENT STAGE OF DEVELOPMENT (FROM THE EAST).

that fact. The lower, near its junction with the Tees and in Brignal, is due partly to capture and partly to the transition from the second to the third cycles. It is explicable on the hypothesis that the uplift took effect on the Tees here after the diversion of the Greta to the Brignal arc. In this case the uplift had not affected the Greta, by way of the Swale, before its capture; and, as the Tees cut downward, and so lowered the base-level, the effects of capture and uplift acting together would accentuate the change of slope on the lower Greta. The abrupt change of slope on the lower part of the Sleightholm Beck is due to the fact that its valley overhangs that of the Greta. This remote beck is not yet affected by the third cycle.

These conclusions as to the development of the river system and topography of Middle Teesdale are illustrated in the last diagrams (Figs. 8). The first represents the Stainmore peneplain, with its consequent streams and the effects on their directions of the higher areas to north and south. The second represents this surface late in the second cycle, after the opening of the chief transverse fault-line valleys. And the third attempts to indicate the complex streams and topography of the district to-day.

Dr. J. S. OWENS: We have to thank Mr. Fawcett for the great amount of work which he has put into this paper. It is obviously one which required careful study, and the inferences which he has drawn could only have been drawn after very careful observation. It describes an interesting example of the development of a river system, and, although it is rather a psychological than a geographical point, it does indicate the advantage of the power of inference in a geographer. You see the facts before you, but you must be able to draw your inferences; in the absence of ability to draw correct inferences it is very little use observing bald facts. Mr. Fawcett has illustrated this in his attempt to date the time of changes from the positions of gorges and the strata cut through—whether the gorges cut through boulder clay or otherwise. Another point touched on was the shifting of water-partings by erosion. A water-parting, like some of those Mr. Fawcett has referred to, is often very vague in its position. Obviously it may shift to either side as one or other stream obtains the upper hand in erosion, and it might never occupy a very definite position until the streams had become practically mature. This leads one to the obvious inference that the final site of the mature river depends not so much upon the original configuration of the land as upon the nature of the materials the river has to cut through. Arising from the reference to a post-glacial uplift in the region referred to, I suggest as a point of interest that one perhaps does not realise the very important effect on the water-level of the sea which the melting of enormous volumes of land-ice produces. Ice which is on the land is so much water abstracted from the sea, which, when it melts, runs back into it, and the effect on sea-level may be anything but a negligible quantity—for instance, the melting of the ice on the Antarctic continent would raise the sea-level several feet.

Mr. ARTHUR HOLMES: There is, I think, one point which I might mention, though it is in connection with a much wider subject than that discussed in the very interesting and lucid paper to which we have just listened. Mr. Fawcett told us that the gorges of the Greta and those of some of the neighbouring streams have been cut below boulder clay, and have for that reason been entirely eroded since the close of the Glacial Period in England. Then, again, he told us that a river whose course has been artificially controlled has carved a valley 6 to 10 feet deep during the last century. I would like to ask him whether it is possible by combining data of this kind to get some idea, in an actual number of years, of the time which has elapsed since the close of the Glacial Period. In New South Wales observations of a similar kind have been made—I think by Prof. T. Edgeworth David—on the streams flowing from the massif of Koskiusko, and from them it has been deduced that the close of the Glacial Period in that part of the world dates back more than 15,000 years. By a totally different method Baron De Geer has shown that since the last ice-sheet lay over the southern coast of Sweden a period of 12,000 years has elapsed.

Should Mr. Fawcett consider his data to be worthy of such an extension it would be interesting and significant if he could ascertain whether post-glacial erosion in the Tees Basin leads to an estimate of time comparable with those determined in other areas.

Mr. BECKIT: Mr. Fawcett's paper has not disappointed the high hopes induced by his very competent work with us at Oxford. The only general criticism which I have to raise, I am well aware, is hardly a fair one; but seeing that this is a Geographical Society, I will make it. I was rather sorry to find there was no reference to the effect of the land-forms that he so very lucidly demonstrated to us upon human geography—by which I mean the space-relations of all human activities. I believe we can look forward to an attempt by the author of the paper to fill this gap. My own view is we can well correlate even a quite systematic geomorphology with human activities, and though I am not really familiar with Teesdale, in other areas I think I have assured myself it will not be a vain correlation.

Most of my other points are matters of comparative detail, some of them merely questions to which I shall be glad if Mr. Fawcett will give answers. Apart from such questions there are two matters that deserve mention. In the first place I would rather like to quarrel with the author's use of the term "mature," although I think it is pretty normally so used. In employing terms borrowed from life and applying them to land-forms, such terms as "old" and "young" are purely relative, but I believe that in "mature" you have the one and only term which is perfectly definite and precise, and that the point of maturity divides the physiographic cycle into two halves, the first half where the effect of the physiographic agents is, on the whole, increase of relief, and the second half where it is the reduction of relief. That is to say, if one regards the valleys only, maturity is reached when the valleys are at their deepest, not necessarily when they are widely opened. But to make a more general point, I think a great deal too much is made of the treatment of valleys in physiography rather than of the treatment of the landscape as a whole. Some of that fault I wish to congratulate Mr. Fawcett on having avoided, but he will perhaps allow me to suggest that a little of it remained. No doubt the reason why valleys have been elaborately treated, rather to the exclusion of the rest of the landscape, is the greater simplicity of the orderly physiographic changes which have been so well worked out in this and many another paper. There is consequently a good deal of obscurity, in some minds I expect some doubt, as to whether there is any orderly series of changes affecting the landscape away from its intersecting valleys.

I proceed at once to my questions, three in number. In the printed summary of the paper we are told that the area dealt with was limited towards the east by the edge of the Carboniferous rocks. I should like to know why that geological feature was adopted. Secondly, a suggestion was made that there was no relation between the land forms and the rock structure. I am not quite clear whether this meant the posture of the rocks or their character—that is to say, their resisting power. I imagine it meant the former. Finally, I would ask whether some of the obscurities which remain even in the author's mind are not due to a rather too simple notion being adopted of the Ice Age, and whether the complexities of physiographic process resulting from climatic changes during that long period will not help to explain some of these still dubious matters.

Mr. FAWCETT: Mr. Holmes suggests the question of calculation regarding the end of the Ice Age. I am very dubious as to how far any one would be

justified in calculating from such observations as we have. What did strike me while Mr. Holmes was speaking was that if I were to transfer the rate of cutting in the Sudburn Gorge, say 9 feet in a hundred years, to the Brignal Gorge, the result would give us 18,000 years, which is a very fair approximation to the figures mentioned. On the other hand, I do not think it is fair to apply the calculation from this area to that; because in this case the beck was cutting down in an area which was mainly alluvium, while the other has cut down into limestone—that is, the resistance is very different; and the power of the two streams is different. With these considerations in mind, I do not think a calculation of any number of years based upon them is of any value at all. That is not sufficient evidence on which to base a calculation. I am very grateful to Mr. Beckit for his criticism. I did not refer here to the influence of the land-forms on the human geography of the area, though I really started to study the area from the side of the human geography. I found the river system somewhat complex, with certain relations which appeared to stand out. Certain inferences came to my mind. The inferences needed to be checked very carefully, and I found I was led on to a study of the whole river system. From the human point of view the valleys which I have called the mature valleys are the important part of the area. The upland plain is mostly above the 1000-foot line—that means above the limit of cultivation in this district. The mature valleys are cultivated areas. I have used the term to describe a valley which is wide and well opened, with its floor fairly smooth and flat, and along which the stream has a gentle fall. Where the stream is deepening its channel further I do not speak of the valley as "mature"; so the "mature" valleys pass into the gorges of the younger cycle. The area above the valleys I left out from any consideration, mainly for the reason that in the greater part of this district it is of much less human importance. With regard to the edge of the Carboniferous rocks, I found on looking at the map that this boundary to the east, the Roman road which runs across it, happens to be also a Local Government boundary; therefore, as far as statistics are concerned, it is a useful boundary to take. It happens also to coincide roughly with the passage from the Carboniferous rock to the younger rock; and, lastly, it marked off conveniently for the purpose of the Oxford work the area which I required to take. Also the Roman road, going along the edge of the lower ground, cuts off fairly well the mouth of the dale. Here we have a line which is a parish boundary, and is also drawn conveniently across the mouth of the dale. I intended to imply that the distribution of the plain upland surface, of the mature valleys and of the gorges, is not associated with the distribution of any type of rock. There are mature valleys in all three types of rock; there are gorges in all three types. The rock structure certainly influences the land-forms in several directions. The cross valleys of the Tees are largely along lines of faulting in the rocks. The effect of the complexity of the Ice Age is one which I have not overlooked, but have not been able to work out in any detail, since for the last few years I have been engaged in the south of England, and can only get to this district once each year.

THE CENTRAL LAKES OF WESTRALIA AND THE WESTRALIAN PENEPLAIN.

J. W. Gregory, D.Sc., F.R.S.

This paper is one of a series read to the Geographical Section of the British Association in Manchester, September 1915, *on observations made during the Association's visit to Australia. Its publication has been delayed until after the examination of some Bryozoa from Norseman, kindly sent to the writer by Mr. E. S. Simpson of the Geological Survey of Australia. A note on these fossils has been published from this in the 'Geological Magazine,' July* 1916, pp. 320, 321.

IN young countries like Australia the maps and literature do not give an adequate idea of existing geographical knowledge, for much of the current information is still unpublished. When resident in Victoria I several times urged the publication of a newer edition of the topographical map of the state; but the admirable prejudice against issuing incomplete work led to delay, in order that further deficiencies should be remedied. One of the valuable influences of the British Association work is that it secures the issue of summaries of existing knowledge regarding the district around its annual meeting-place. The handbooks issued as part of Australia's magnificent welcome to the Association are a most important contribution to the scientific literature of Australia; and among these publications may be included the excellent "Contour Map of Western Australia. South Sheet" (scale 1 inch = 30·6 miles) issued by the Department of Lands and Surveys. (I understand that this map was mainly compiled by Mr. J. J. East, of the Lands Department of Western Australia.) It was probably prepared in readiness for the British Association visit; it is dated 1913, and Mr. Heawood informs me that a copy was received by the Royal Geographical Society's Map Department on 29 December 1913,* but I had seen no reference to its publication, and was first aware of its existence on arrival with the Association in Australia. Accordingly a paper on "The Lake System of Westralia" published in the *Geographical Journal*, June 1914, was written without the help of this valuable map.

The central part of the map is no doubt diagrammatic, and it will doubtless undergo modification in detail; but it is a most important contribution to the knowledge of the relief of Westralia. It throws much light on the ancient river system of that state and suggests some unexpected conclusions. According to this map some of the rivers, of which the ancient lakes of Westralia were expansions, followed different courses from those suggested in my paper. The most important difference is in regard to the outlet of the group of lakes including Lakes Barlee, Ballard, and Raeside. According to the new map Lake Raeside

* Noticed in *Geographical Journal*, February 1914, p. 229.—ED. *G.J.*

discharged into Lake Ballard, which had its outlet to the south-west, where it was joined by the overflow from Lake Barlee and Lake Giles. The overflow from all these lakes would then have passed through Lake Deborah into the Swan River. On my sketch-map it is suggested that Lakes Ballard, Barlee, and Raeside probably discharged south-eastward into the sea which once extended inland from the Great Australian Bight over the Nullabor Plains; and the course of the 1250-feet contour line on the new map of Western Australia, shows some features which indicate that the original discharge from these lakes was in that direction. Extensive areas around those lakes are below the level of 1250 feet, whereas near Lake Deborah the 1250-feet contours come close together; hence, according to the contour map, the drainage of a very large area below 1250 feet escaped through a comparatively narrow gap at Lake Deborah. Lake Raeside is at the level of under 1200 feet, for the railway levels station at Melita, about 2 miles south of the lake, is at 1190 feet. The railway crosses the depression of Lake Ballard a little to the east of the lake; and the lowest level there, which is mentioned in the railway time-table, is 1230 feet. According to the new contour map, however, Lake Raeside should be at a higher level than Lake Ballard, through which is its only outlet. I was assured in Perth that the contour map is reliable for this district; and if so it represents the drainage at a later date than that of my sketch-map. That the lakes of the Barlee–Ballard–Raeside group originally discharged south-eastward to the Great Australian Bight seems the only course consistent with the railway evidence as to the altitude of Lake Raeside; and it is the most probable course in such country, since Lake Raeside is more than four times as far from the Indian Ocean as from the Southern Ocean.

The marine deposits of Lake Cowan show that West Australia once stood 1000 feet lower than its present level; and under these conditions the natural outlet of the drainage from the central lakes would have been south-eastward into a gulf, which is indicated on the contour map, to the north-east of Queen Victoria Spring. There appears no adequate physiographic obstacle to this course, for the contour map represents the highest ground between Lake Raeside and the lowlands to the south-east as varying from only 1250 to 1500 feet in level. Even should there not be at present any depression in this ground below the level of 1200 feet, its absence would be easily explained. As the rainfall in this part of Australia diminishes eastward, there is less rain to the east than to the west of Lake Raeside. Hence wind-borne drifts may have accumulated more quickly in the valleys between Lake Raeside and the Nullabor Plains than in those further to the west; and thus the original outlet to the south-east may have been blocked, and the drainage of the central lakes may have been diverted to the route through Lake Deborah.

Another unexpected conclusion suggested by the new map is with reference to the outlet from Lake Way. According to that map the basin

of this lake is 24 miles wide at the contour of 1750 feet, and it discharged through a valley, which, 60 miles from the lake, is in places only 4 miles wide at the same contour; and the drainage from Lake Way would have flowed first eastward, then north-eastward, and through the Lindsay-Gordon lagoon to Wells Creek, which joined the old river system connected with Lake Carnegie and Lake Wells. These lake basins are separated from the lowlands to the north of the Nullabor Plains by land over 1750 feet high. Hence the only outlet from this group of lakes would have been to the north-east through Lake Burnside, and the drainage would have reached the south-eastern country, below 1000 feet in level, by a comparatively narrow gap between Remarkable Peak and Mount Worsnop. My sketch-map, on the other hand, represented the drainage from Lake Way and Lake Wells as having discharged directly southward, Lake Way having drained to Lake Raeside through Lake Miranda and the "Great Salt Lake" south of Lawlers, and Lake Wells having drained through Lake Carey. According to the contour map this outlet from Lake Way is barred by a tract of country which is above the level of 2000 feet and joins the Barr Smith Range to the Sholl Range. In 1908 I passed over this range between Lake Way and Lake Kathleen, and the views eastward suggested the existence of a wide depression to the east of the Barr Smith Range, so that the discharge from Lake Way could have reached Lake Miranda, which is about 200 feet lower than Lake Way. It is however possible that both Lakes Way and Miranda were connected through Lake Darlot (1825 feet) to Lake Carey (1300 feet). The outlet from Lake Way cannot be settled until the relief of the East Murchison and Mount Margaret goldfields are better known. If there be no depression below the level of 1800 feet between the Barr Smith Range and Lake Wells, and if ground above the level of 1750 feet be continuous from Laverton eastward through Mount Venn and the Newland Range nearly to the Rowe Hills, then the drainage from Lake Way and Lake Wells must have followed the apparently less probable and very circuitous route to the north of the Mount Margaret goldfield.

During the British Association visit I had the pleasure, owing to the friendly arrangements of Mr. G. C. Larcombe, and the kindness of Messrs. Cutbush and Davies, the Mayor and Deputy-Mayor of Kalgoorlie, of examining another of the Westralian lakes. They took me to the northern shore of Lake Lefroy in Mr. Davies' motor, in an excursion which will always remain a delightful memory. The shore of the lake is well defined, with lines of low cliffs, muddy beaches, and small deltas, while isolated rocks rise like stacks and islands through the sheet of mud that forms the floor of the lake. The form of the land does not appear to have undergone any considerable change since the lake was filled with water. The shore is so little altered that if it had been formed by a tidal sea we might reasonably expect to find remains of its shingle beaches and to collect marine fossils from its shore deposits. If their

absence be explained by burial beneath later drifts, then the cliffs and present shore-line were lacustrine and not marine; while bores put down in the central lakes, as at Kalgoorlie, have revealed lignitic lacustrine or subaerial beds, but no marine deposits. The visit to the sinuous shores of Lake Lefroy strengthens my conviction that the lake basins of Westralia belonged to true lakes and not, as has been suggested, to inlets from a tidal sea.

This opinion had been previously expressed in regard to the Ponton River in Mr. C. G. Gibson's memoir on the geology along the route of the Transcontinental Railway (Geol. Surv. W.A., Bull. 37, 1909, p. 12). In my reference to the literature of the lakes I had unfortunately overlooked Mr. Gibson's interesting observations on the Ponton River. He describes it as a chain of lake basins, and attributes it to "a very fair-sized river flowing in Tertiary times into the sea which then covered that portion of the country now occupied by the Eucla Limestone Tableland." Mr. Gibson had therefore adopted for the Ponton River the conclusion as to the age and nature of the Westralian lake basins that I reached independently the same year.

The conclusion that Westralia was once 800 or 1000 feet lower than it is now helps to explain the general nature of the Great Plateau of Western Australia. Mr. Jutson, in his admirable "Outline of the Physiographical Geology of Western Australia" (Geol. Surv. W.A., Bull. 61, 1914), recognizes the marginal belt as an uplifted peneplain and suggests that the great plateau of the interior may be the same; but he hesitates to adopt the term "peneplain" for the interior, since its surface may have been levelled by denudation under arid conditions. Mr. Jutson remarks (pp. 92 f.) the present tendency to extend the term "peneplain" to plains formed by arid erosion. This extension may appear to be consistent with Prof. Davis's original definition of the term—" . . . all this part of the country was reduced to a nearly featureless plain, a 'peneplain' as I should call it, at a low level." (The term was proposed by Professor Davis in 1889, *Amer. Journ. Sci.*, ser. 3, vol. 37, p. 430. The original definition does not include a low level as essential, for the fact that the typical peneplain happens to occur at a low level is stated after the definition. The New English Dictionary (1905) expresses the same view in its definition of a peneplain as "a nearly flat region, a tract of land almost a plain.") The two characteristic features of the peneplain, according to the original description, are "a nearly featureless plain" and formation by subaerial denudation. Prof. Davis in many later explanations of the term included formation at a low level as also indispensable (for example, 'Phys. Geogr.,' 1898, pp. 152 f.; reprinted in 1902 in Davis's 'Geogr. Essays,' p. 387). The essential feature in a peneplain appears to be its formation by denudation at base-level, and the actual height above sea-level is immaterial. Hence plains at base-level on the floors of highland basins, as that of the Bahr-el-Ghazl on the Upper Nile, may be

reasonably called peneplains. The extension of the term to all wind-levelled plains is however inadvisable. Prof. Davis has expressly excluded plains due to arid erosion (*Jour. Geol.*, 1905, in 'Geogr. Essays,' p. 310). The peneplain conception has been very useful, but if the term be so widened as to include all wind-levelled plains it becomes so vague as to be useless.

The indefiniteness which has come to the term "peneplain" indicates the difficulty in its precise delimitation. There is, for example, no single reliable criterion to separate peneplains from plains of marine denudation; and the permanent adoption of the term may depend on its limitation to its original meaning of a featureless plain that has been worn to base-level by river erosion. Tarr's criticisms (*Amer. Geol.*, vol. **21**, 1898, pp. 351–370) of the peneplain theory would be valid were it not that geological processes, though uniform in nature, have not been uniform in rate. True peneplains are formed during the long periods of rest between epochs of comparatively quick movement.

If Western Australia stood 1000 feet lower than its present level at the date of the rivers of which its lakes are relics, most of the existing plateau surface would have been formed as a true peneplain. The remarkable uniformity of its surface can be more easily explained as a base-levelled than as a high wind-levelled plain, and the sudden break on its western and southern margins may represent the approximate position of the former coast. The existence of these lakes supports Mr. Jutson's suggestion that the plateau of Western Australia is a great uplifted peneplain; for its wide central plains were probably due to base-levelling by Miocene rivers during the long interval of repose before the great Pliocene uplift.

The distribution of the oases in Western Lybia and Tripoli may represent a further stage in the development of such disappearing river systems as that of Western Australia. Judging from the altitudes and position of the oases and their apparent connection by belts of lowland, they are probably relics of ancient river systems. Thus the oases from Kufra to Siwa are probably depressions on the line of an ancient river which flowed north-eastward across south-eastern Tripoli into Egypt. It began as the Wadi al Fardi, which rose on the Tibesti Mountains at about 19° S. and 20° E.; it flowed through the oases of Kufra (1000 feet) and continued down the slope to the north till it either passed through Aujila (130 feet) or was joined by a tributary from that oasis. Its further route was through the valley from Aujila to Jarabub and Siwa (70 feet below sea-level). The lake stage of any such Kufra river system has long since been obliterated by the wind-borne drifts of the Libyan desert. Further south on the Tibesti Mountains rose the Wadi Howar which discharged to the Nile at Dongola. The oases of Gatun and Murzuk were probably the upper valleys of a river the outlet of which may have been through Sella to the Great Sirtis.

The age of the uplift of Western Australia indicated by this ancient river system depends on the date of the Norseman limestone. Mr. E. S. Simpson has kindly sent me some fossiliferous specimens of this rock. The fossils are poorly preserved, but the evidence of some mollusca, as interpreted by Mr. A. E. Kitson, suggests that their age is earlier than Pleistocene. The five determinable species of Bryozoa all occur in the Miocene deposits of Victoria, and three of them are confined to that horizon. Hence the evidence of these fossils, though inadequate for a positive conclusion, supports the Miocene age of the Norseman limestone and of the subsidence during which the West Australian plateau was more than 1000 feet below its present level.

[*Note:* The abbreviation Westralia for Western Australia, used by Professor Gregory in this and a former paper on the same subject (*Geographical Journal*, June 1914) is not recognized by the Government of Western Australia, and is not in use officially in that State. Its employment in the above papers should not be taken as implying its general recognition by the Society.]

THE MAPPING OF THE EARTH, PAST, PRESENT, AND FUTURE.

Edward A. Reeves, Map Curator and Instructor in Survey, R.G.S.

Presidential Address to the Geographical Section, British Association for the Advancement of Science, Newcastle-on-Tyne, 1916.

WE meet to-day under exceptional circumstances. The great War is affecting us all; those of us who are not actually engaged in it find that our lives are more and more under the influence of the struggle that is now taking place, and we are being called upon to do what we can to carry on the work of the men who have gone, as well as our own. This is the explanation of my presence here to-day. Mr. D. G. Hogarth, who was to have been our President this year, has been compelled to resign owing to his absence from England on important military duties; and a week or two ago I received a letter from the Secretary of the Association asking if I could help our Section out of the difficulty in which it was placed by agreeing to take the chair during the meeting. There seemed nothing else for me to do but accept, so I am here, and will do the best I can to fill the gap. With your kind indulgence, and the invaluable help and guidance of the recorder, secretaries, and committee, I trust we shall manage to get through without bringing discredit on ourselves.

You will understand that, as the notice was so short, I have had no time to prepare an address such as I should like to place before you; that which I shall now give has been hastily put together during a few days' holiday at the seaside, from notes and jottings I have recently made for other purposes, combined with such remarks as I feel may be appropriate to the conditions under which we meet.

This is a great testing time—a crisis in our history when theories are put to practical trial, and I fear many of them will be weighed in the balances and found wanting. Scientific training is being especially tested, and almost every branch of human knowledge has, either directly or indirectly, been called upon to do its utmost in connection with the great War. This is certainly true of surveying and geography generally. There has always been of necessity a close connection between military operations and map-making, and it is not too much to say that one of the essential conditions of successful warfare is a good and accurate knowledge of the geographical features of the theatre upon which the operations have to be carried out. Many a battle has been lost in the past, as we ourselves know to our cost, through imperfect topographical or geographical knowledge. The South African campaign, without referring to any others, produces more than enough evidence of the serious results ensuing from imperfect maps; and at the present time the general staffs of all combatants seem more than ever alive to the importance of this subject.

There are various ways in which this war will affect the map-maker; not only will new boundaries have to be surveyed and laid down, but outside of Europe districts will have to be mapped for which little information has hitherto existed, so that, after all is over, our present maps and atlases will be out of date, and the publisher will find himself called upon to produce new ones.

It therefore appears to me that this is a suitable occasion for taking stock of our position, and I will endeavour to give you:

(1) A brief general summary of what has been done in the past towards the mapping of the Earth's surface;

(2) A sketch of how things stand at the present time; and

(3) A few remarks upon future work, specially as regards instruments and methods.

You will perceive at once that this is a large subject, and in the time at my disposal I shall only be able to deal with it in the briefest possible manner.

The acquirement of knowledge has always been progressive, sometimes moving slowly, at others more rapidly, but ever advancing; and this is specially true of the subject we have to consider. Our present knowledge of the Earth, its form, size, the configuration of its surface features, their measurement and representation on maps as we see them to-day, are the result of many centuries of strenuous endeavour, and conquest over obstacles, and at times almost insurmountable, the record of which constitutes a striking monument to indomitable courage and perseverance such as cannot be excelled in the history of mankind.

Of all branches of human research and discovery that of geographical exploration and representation of the surface features of the Earth is doubtless one of the oldest; in fact, it is difficult to imagine a time in the history of intelligent man when it did not in some manner or other exist. The Earth's surface is, by the nature of things, man's present dwelling-place, and, however high and far he may soar in imagination and thought, as to his bodily presence his movements and operations are practically restricted to the crust of the comparatively small planet he inhabits. By his very nature man is an adventurer and a restless wanderer; and, since his physical constitution does not permit of his travelling more than a comparatively few feet vertically, his only chance of expansion is laterally or horizontally; and geographical investigation and measurement became a natural consequence.

From the earliest days there would arise the need of some sort of plans and maps; there would soon be boundary questions to settle, and the limits of

pasture-lands, and irrigation rights, mining-claims and other matters would call for maps of some kind, however rough they may have been; so it is quite impossible to say when surveying commenced. It certainly must be one of the oldest departments of knowledge, and, like all others, has slowly advanced as the centuries have passed and greater accuracy was required until it has reached the refinement and precision of the present day.

Probably the earliest attempts were those which naturally resulted from the necessity of representing in some kind of plan the limits of private property, and several interesting examples of this have been brought to light during archæological investigations and discoveries in Egypt and other ancient sites.

A careful reader of the account of the dividing of the land of Canaan among the tribes of Israel can hardly fail to come to the conclusion that Joshua had some sort of a map of the land before him when he proceeded to apportion the various districts, the boundaries of which are so minutely and carefully described; and it is also more than probable that he and others who had been sent beforehand to spy out the land "had in view quantity as well as quality," as Gore says in his 'Geodesy,' which implies some kind of rough survey and sketch-map.

At a later period we have the vision of the man with the measuring line in his hand, measuring out his thousands of cubits, apparently much as a chainman does his work to-day.

So long as the district concerned was of no great extent there could have been little difficulty about making a rough plan or map of it. For lineal measurements the most natural units would be the lengths of various parts of the human body. The cubit, the pace, the foot and the span were evidently amongst the earliest standards of all, and most of these have remained in use until this day. With these, and an elementary knowledge of some of the simpler geometrical figures, it would be easy for quite useful plans to be constructed, as indeed we know was the case. The longer distances were reckoned by the time it took to travel from one place to another, days' journeys, etc.; and later on in stadia, of which it is generally assumed that there were 600 to a degree according to the ordinary Greek measure.

When distinctive features were visible it would be comparatively easy to map roughly a route travelled, much as a man in the present day can make an approximate sketch to show any journey he has taken, even without a compass or other instruments; or as natives have been able to draw rough sketches to explain to explorers the direction of any coast-line or course of a river. One of the most recent examples of this is the map reproduced by Mr. Beaver, which was drawn in the sand by a native of Papua to show the relative position and names of the various tributaries of a river he was exploring (see *Geogr. Journal*, April 1914).

Long before the magnetic compass was known, at any rate in Europe, navigators and travellers had to find their way somehow, often through little-known regions, and, when they had no landmarks to direct them, would have to seek some other means of guidance. Early nomad peoples of the desert would soon become acquainted with the heavenly bodies and their general movements and positions, and would naturally turn to them for the guidance they sought. Their positions at certain times and seasons would, through being continually observed, become quite familiar, and so doubtless before any instrumental astronomical observations for fixing positions were made, men learned to march and steer their ships by the sun by day and the stars by night. It is interesting to note that the art of marching by stars has been considerably revived in the

last few years, especially in the rapid movement of troops at night. So long ago as the seventh century B.C., Thales had taught the Ionian sailors to steer by the Little Bear, as did the Phœnicians.

One of the most interesting exploring expeditions of ancient times was that of Pytheas, the discoverer of Britain, in the fourth century B.C., who had not only learnt to sail by the stars, but determine the latitudes of points throughout his voyage by astronomical observations, made with a gnomon or sort of sundial, with which he seems to have fixed the latitude of Marseilles with far greater accuracy than might have been expected.

The gnomon used by Pytheas was probably of the earlier form, which consisted merely of an upright rod in the centre of a flat disc ; but Aristarchus, in the third century B.C., introduced a decided improvement in the design of this interesting old instrument, which deserves to be borne in mind by all surveyors, since it seems to have been the first by which angles could be measured directly without computation. He substituted for the flat disc, or plate, a hemispherical bowl, in the centre of which an upright rod was fixed equal in length to the radius of the bowl. Concentric equidistant semicircles were drawn on the interior of the bowl, which became a scale for the direct measurement of angles of altitude as indicated by the shadow of the rod or gnomon.

The voyage of Pytheas is of special importance, since it shows that even at that early date serious attempts were made at carrying out geographical exploring expeditions, by sea at any rate, on scientific lines.

The first record of anything that could be considered as the beginning of geodetic surveying was the well-known attempt of Eratosthenes to ascertain the size of the Earth by the measurement of an arc of the meridian. This wonderful old philosopher was born in Cyrene in B.C. 276, and was so noted for his learning that he was put in charge of the famous library at Alexandria. The method he adopted was much the same in principle as that upon which geodesists at the present time work, but it seems impossible to say how near the truth his results were, as there is a doubt as to the length of the stadion he used.

The subject of the true form and dimensions of the Earth is a most important one in many respects ; it considerably affects survey questions, since it must form the basis of all exact measurements on the Earth's surface. Right on to the present day geodesists have been working at it, and although they have brought down the probable error in the measurements to what must be almost a minimum, yet even now the question cannot be taken as finally settled.

As regards the maps of very early date, it has always been a question as to how far they were the outcome of mere information collected by travellers without any attempt at instrumental measurement, and how far they were based upon some kind of route-surveying and astronomical determinations. At sea, as has been shown, occasional observations were made to determine latitude, but the actual charting of the coast-line, it is more than probable, was sketched in in the roughest possible manner, with little assistance from any kind of instruments. After repeated voyages the navigators would naturally obtain some acquaintance with the general configuration of the coast-lines and be able to draw a fairly accurate chart. These rough sketches were sent from one to another and copied by hand by cartographers ; so in course of time quite a good representation was produced. It is indeed remarkable how accurate some of these old charts were. A rough latitude could always be obtained from observation, but it was quite another thing with longitude. Even at the present day there is far more uncertainty about a longitude than a latitude observation, and in early days, before the construction of accurate chronometers, to obtain the

difference of time or longitude between two places was a problem which could not be satisfactorily solved with the rough instruments and tables available. Consequently the longitudes on early maps were, as a rule, very wrong. They were generally much too great, as the tendency was, as it is indeed at the present time, to exaggerate the distance travelled.

As might be expected, now and then serious mistakes seem to have been made in the fitting together of sections of charts received from various sources. This was probably due to the fact that in many cases they were rough copies from other copies of the originals, and, with no proper means of settling the orientation, the chart would, as likely as not, be fitted on to another at quite a wrong angle. This is doubtless the explanation of some of the grosser errors on many of the old maps. For instance, in the early editions of Ptolemy's maps, 1462 (72)–1490, to the north of England there is a remarkable mass of land running something like east and west, and projecting a long way in the former direction. This is, of course, meant for Scotland, but it is difficult to see how it could have got so wrongly drawn. Yet if you suppose the whole mass turned round at right angles, so that the part that goes to the east is placed to the north, you get a much better representation. There seems little doubt that somehow or other the whole thing was wrongly joined on to England. In later editions of Ptolemy it was corrected.

The best-known of all the old instruments is the Astrolabe, which is generally supposed to have been invented by Hipparchus about B.C. 150. Ptolemy, and many others after him, introduced modifications in it, some of which were doubtless improvements, while others, as is the case with many so-called improvements in more modern instruments, were of doubtful value or merely unnecessary incumbrances. Divested of all elaborations the astrolabe consisted of a somewhat heavy metal ring suspended from the thumb, or, in the case of the larger instruments, hung on some form of tripod arrangement. Pivoted at the centre was the movable sighting rule or alidade, and the altitude of the sun or star was read off on the graduated circle round the circumference of the disc.

During the mediæval ages things were at a standstill, or rather went backwards, as regards all scientific pursuits, at any rate in Europe. This in a special manner affected geography and map-making. The advance that had been made by the Greeks was arrested, and the knowledge they had gained was lost sight of; instead of maps being improved by more accurate surveys of explorers and travellers, they were frequently drawn in monasteries by monks from imagination, more or less distorted by religious bigotry. Cartography fared somewhat better in the hands of the Arabs, but many of the maps seem to have been constructed under impressions that the outlines of all parts of the world must be formed by straight lines and arcs of circles, drawn with a ruler and compass, so that they are of little real value. There were, however, a few notable exceptions.

It was not until the latter part of the fifteenth century, the time of the great Portuguese and Spanish discoveries, that any real advance was made; but then Europe seemed to awake from a long sleep, and a grand new start was made.

One of the first acts of King John II. of Portugal (1481–95), whose memory deserves to be equally held in respect with that of his great-uncle Prince Henry, was the calling together of the Committee, or "Junta," of learned men, already referred to, to consider the best means of finding the latitude when the Pole-star was too low to be of service, to decide upon the most approved form of instrument for the taking of observations, and to furnish suitable tables of declination, etc., for the computations. Equipped with the new tables, which

may, perhaps, be considered the first Nautical Almanac, and the simplified astrolabe, the Portuguese navigators started on their famous voyages, with a much better chance of properly fixing positions than their predecessors. The vernier had not yet been invented, and so the difficulty of obtaining accurate readings of the circles was still considerable. To overcome this difficulty it was decided to construct astrolabes with very large circles, and the instrument carried by Vasco da Gama in his famous voyage round the Cape in 1497 had a circle which measured just over 2 feet in diameter. The size of the instrument certainly made it unwieldy, and so it was necessary to suspend it from some sort of stand, which meant that it could not have been used with much success on board ship. Vasco da Gama seems to have been fully alive to this, and so we find him, when he arrived at St. Helena Bay, not far from the Cape, bringing his instrument on shore and fitting it up on a stand. His observation and method of obtaining the latitude of this spot is of considerable interest, and may perhaps be taken as a fair example of the kind of work that was then done.

The sun's meridian altitude measured was 76° 20′, which gave a zenith distance of 13° 40′. The declination found from the table was 19° 21′ S., so by adding this to the zenith distance the resulting latitude was 33° 0′ S. I have recently tried to find out how near this was to the true latitude, but it seems to be difficult to say exactly where the instrument was erected. If we take the head of the bay as the spot the error is apparently 13′, since the latest Admiralty chart gives 32° 47′ S. This error appears to be somewhat larger than might have been expected, but still, taking all things into consideration, it was not so bad after all. I have on several occasions made altitude observations with rough home-made instruments of the astrolabe type, to see what could reasonably be expected, and have found that with care it is possible to get a latitude with an error not exceeding 5′ to 7′, taking a mean of several readings.

The difficulty of taking anything like accurate observations at sea was for centuries a very serious one, and long before the invention of the reflecting quadrant or sextant many were the attempts to devise some instrument for accomplishing this.

Next to the astrolabe, and various forms of quadrants with a sighting arrangement and plumb-bob, the old cross-staff came into use. This consisted of two rods or pieces of wood at right angles to each other. The shorter piece had a hole in the centre, and was made to slide along the other. The eye was placed at the end of the long piece, and the sliding piece or cross moved along until one end of it cut the sea horizon and the other the sun. The altitude was then read off on the long staff, which was graduated for the purpose. This was essentially a seaman's instrument, and was in common use about three hundred years ago—in fact, until the famous old Arctic explorer, Captain John Davis, of the sixteenth century, improved upon it by bringing out his "Back-staff," which enabled a man to take altitudes with his back to the sun instead of half blinding himself by looking straight at it.

With instruments such as these only the roughest measures could be obtained, and it was not until the ingenious invention of the reflecting octant, suggested first of all by Sir Isaac Newton, that anything approaching accuracy was possible. Hadley's quadrant was the first of such instruments to be put into actual use, but there is no doubt that the idea should be ascribed to the famous Sir Isaac Newton, although the instrument was probably independently invented by Hadley.

With the invention of the sextant, or its predecessors the octant and

quadrant, rapid progress was made in improvements in navigation and surveying instruments.

The introduction of the Nonius by Peter Nuñez in the middle of the sixteenth century, and later of the Vernier by the Frenchman Francis Vernier, which, owing to its simplicity, soon superseded the former, were of great importance, since it was no longer necessary to construct the large arcs and circles which had hitherto been indispensable to give anything like accuracy.

The magnetic compass not only made an enormous difference in navigation and exploration by sea, since it enabled the sailor to launch boldly out into the unknown oceans with confidence, but it soon began to leave its mark on land-surveying and geographical exploration. Much has been written on the invention of the compass, and many have been the disputes upon the subject, but it was certainly in use in Mediterranean countries of Europe as early as the twelfth and thirteenth centuries. The date when it was first used for land-surveying is not known exactly, but in Europe it was probably about the early part of the sixteenth century.

For the filling-in of the topographical features early forms of the plane-table, or their prototypes the trigonometer and graphometer, came into use in the sixteenth and seventeenth centuries. Besides these the surveying perambulator, much as is used at the present time, was a favourite instrument in measuring distances along roads, and many of the road maps of England before the Ordnance Survey were made by its means, combined with compass bearings and circumferator angles.

It is supposed that Ptolemy was fully alive to the fact that it was not necessary to actually measure the whole length of an arc of the meridian, but that some parts could be computed, or perhaps graphically obtained much as is now done in plane-tabling; but, so far as we know, the first to introduce triangulation from a measured base and angles was Willebrod Snell, a mathematician of the Netherlands, who lived in the seventeenth century. The account of his triangulation for obtaining the distance between Alcmaar to Bergen-op-Zoom, in Holland, is well known, and it is not necessary for me to refer to it in detail here; but its importance cannot be overestimated, since it laid the foundation for all future work. Much has been done in later years, but this has only meant the improvement of Snell's system, the perfecting of instruments for the measurement of angles and bases, and more refinement in the computations.

Of all the instruments used by the surveyor there is doubtless none more important than the theodolite, the invention of which is generally attributed to Leonard Digges. His theodolite is described in his book on surveying, which was completed by his son and published in 1571.

There is an interesting old theodolite of much the same design in Bleaus' famous Dutch Atlas of the latter part of the eighteenth century.

The "common theodolite," as it was called, since it had no telescope, carried by Mason and Dixon to the United States, and used by them in their survey of the boundary between Maryland and Pennsylvania in 1763–9, is now in the R.G.S. Museum. It was made by Adams, of London, and was evidently only intended for observing horizontal angles. It resembles what is generally known as a circumferator more than a theodolite. The famous Ramsden theodolite, which was used on the primary triangulation of the British Isles, and later on in India, has often been shown in books, and doubtless many of you are quite familiar with its appearance. This has now found a resting-place in the Ordnance Survey Office, Southampton.

The surveying equipment of the pioneer explorer of early days, say, of from twenty to sixty years ago, usually consisted of a sextant and artificial horizon, a chronometer or watch, prismatic compass, boiling-point thermometers, and aneroid. With the sextant and artificial horizon the astronomical observation for latitude and longitude were taken, as well as those for finding the error of the compass. The route was plotted from the compass bearings and adjusted to the astronomically determined positions. The latitudes were usually from meridian altitudes of the sun or stars, and longitudes from the local mean time derived from altitudes east or west of the meridian, compared with the times shown by the chronometer, which was supposed to give Greenwich mean time.

The sextant in the hands of a practical observer is capable of giving results in latitude to within 10″ or 20″, provided it is in adjustment, but the difficulty is that the observer has no proper means of testing for centering and graduation errors. The great drawback to the sextant for survey work is that it is impossible to take accurate rounds of horizontal angles with it, since, unless the points are all on the same level, the angles must be too large. It is essentially a navigator's instrument, and nowadays has been almost entirely superseded by the theodolite for land-surveying.

As regards the longitude, the difficulty was always to obtain a steady rate for the chronometer, owing principally to the unavoidable oscillations and concussions met with in transit. Formerly it was customary to observe lunar distances for getting the Greenwich mean time instead of trusting to the chronometers, but these, even with the utmost care, are very unsatisfactory.

In more recent years the star-occultation method of finding the Greenwich mean time superseded almost entirely the lunar distance, but all of these so-called "absolute" methods of finding longitude are fast becoming out of date since the more general introduction of triangulation and wireless telegraphy.

Heights of land were usually obtained by the boiling-point thermometer or aneroid.

This, then, was the usual equipment of the pioneer. With such an outfit the greater part of the first mapping of Africa and other regions of the world was carried out, with results that were more or less reliable according to the skill of the explorer and the time and opportunities at his disposal.

In recent years considerable improvement has been made in the instruments and methods of the geographical surveyor: the introduction of the Invar tape for the measuring of the baselines, the more general application of triangulation, the substitution of the theodolite for the sextant, the more general use of the plane-table for filling in the topographical details of the survey, the application of wireless telegraphy to the determination of longitudes, these and other improvements have all tended to greater accuracy and efficiency in geographical and topographical mapping, so that in many respects the rough approximate methods of the earlier explorers are fast being superseded by instruments and methods more in keeping with modern requirements in map-making.

Still, the principle underlying all surveying is the same, and the whole subject really amounts to the best and most accurate methods of measurement with a view to representing on a plane, on a greatly reduced scale, the leading features of a certain area of the Earth's surface in their relatively correct positions; and so it resolves itself into geometrical problems of similar angles and proportional distances. This being the case, it is clear that it becomes in the main a question of correct angular and linear measurements, and all the improvements in survey methods have had for their object the increased accuracy of accomplishing this together with greater facility for computing the results.

What we do now is exactly what was attempted by the early Greek geometers and others in ancient times, only we have far more accurate instruments. If, for instance, we compare our modern micrometer theodolite with the old scaph of the Greeks the contrast is striking, although both had the same object in view as regards taking altitudes of heavenly bodies. Many of the old instruments, in spite of their great size, were extremely rough, and the angles could only be read with approximation or to a great extent by estimation, while the theodolite which is now generally used on geographical surveys, although it has circles of only 5 inches in diameter, can, by means of the micrometers, be read to 2″ of arc, or even to 1″ by careful estimation. This, when one comes to think of it, is a triumph of refinement, since it really means that we can measure to within about 1/80,000 part of an inch, which is the space occupied by 1″ on the arc of a circle of 5 inches diameter. At least this is the theoretical accuracy, but in practice there are, of course, errors in sighting, setting the micrometer wires, and those arising from other sources which have to be taken into consideration.

The continued striving after greater accuracy of measurement applies not only to angular measuring instruments, but to linear distance measurement as well; and the improvements in apparatus for this purpose, could we follow them in detail, would be most interesting. From the rough methods that would suggest themselves naturally to early intelligent men, some of which I referred to in the earlier part of this address, to the modern baseline apparatus, and accurately computed sides of a geodetic triangulation, is a far cry, and the advance in this matter is certainly remarkable.

Still absolute accuracy of measurement of any kind seems to be an impossibility, and the best we can do, after all, is to approach it as near as we can and to arrange matters so that the inevitable errors will tend to balance one another. Nature herself seems to object to perfection in measurement. For instance, when we attempt to measure a distance, and have taken all precautions we can, changes of temperature occur and alter the length of our measuring-tape, and, in spite of all that has been done by manufacturing tapes of alloys of different metals in order to counteract this effect, uncertainty must exist to some extent. Then as regards our angular measuring instruments, not only must there always be personal error and some imperfections in the graduation and centering, but the change of temperature again comes in, affecting the metal, and attempting to defeat our object of obtaining perfection. If we desire to measure the true vertical angle, there is always the troublesome and uncertain effect of the refraction of the atmosphere, which makes the mountain-top appear in a different place from where it really is, according to the heat, moisture in the air, and all sorts of other unknown causes which, in spite of all the corrections we may apply, occasion at least some uncertainty as to our result, whilst in the case of the sun or star it is considerably worse. So great is this refraction that when the sun appears to be just above the horizon, as you see it over the sea, it is actually not there at all, and has gone down below the horizon. Of course tables have been constructed to correct all this, but no one can say that they are really accurate, as the results depend so much upon local conditions; and they must after all be considered merely devices for making the best of a bad job. Then, again, when we have taken all possible care with the levelling of a theodolite, Nature, through inequalities of gravity, has an unsuspected trick of drawing the level out of its normal position, which introduces uncertainty, and is often most bewildering in its result. But enough has been said on this subject. The only safe rule for a surveyor to follow is never to

assume that he is correct, and to take his observations so that they tend to compensate one another, whenever it is possible to do so.

So far what I have said has had chiefly to do with some of the earlier attempts at surveying and map-making, and the instruments and methods by which these have been carried out; and I will now try to give you an outline of what has been done in comparatively recent times, and state briefly the present position of the various parts of the world as regards the condition of their mapping and the survey basis upon which their maps depend.

Little by little civilized man, by his daring, his love of adventure, and the necessities of events and circumstances, has penetrated into the unexplored parts of the Earth and pushed back the clouds and mists that so long shrouded them from his knowledge, until at the present time the regions that are entirely unmapped are very few indeed, and do not amount to more than about one-seventh of the whole land-surface of the globe, including the unexplored areas of the Polar Regions, which may be either land or water. Not content with a mere vague acquaintance, he has striven for greater accuracy, and has called to his aid various branches of science in order that he may obtain more correct knowledge and a better comprehension of the Earth's features. To enable him to fix with definiteness the position of places upon its surface, map out the various land-forms, and obtain their accurate measurements, he has consulted the astronomer and mathematician. Commencing, as we have seen, with the rudest instruments and measuring apparatus, these, as greater accuracy was required, have gradually been improved, until the present-day appliances and equipment of a surveyor is a wonder of refinement and delicacy.

In order that we may obtain a general idea of what parts of the world have been mapped and what have not, as well as ascertain something of the value of the survey basis for maps of the various parts of the world at the present time, I will now show (p. 344) a map of the world I have recently drawn. It is merely an outline, and diagrammatic in character; but I trust will help to make the matter plain. By way of comparison I have drawn another map showing what was surveyed at all accurately, mapped from rough surveys and entirely unsurveyed and unmapped in 1860—that is, nearly sixty years ago. These maps will, I hope, make the subject clearer to you than if I placed before you mere tables of figures and statistics, which, though important in their place, do not convey to the eye at a glance the facts and proportions that can be furnished by diagrammatic maps and diagrams.

For the sake of comparison of relative areas the maps are drawn on an equal-area projection, that is to say, a certain area on the map, such as a square inch, everywhere represents the same number of square miles on the Earth's surface. The idea kept in view in drawing the maps is that the shade deepens as the accuracy of the surveys increases. (1) The parts that are topographically mapped from triangulation or rigorous traverses are shown by the darkest tint; (2) those that are less accurately mapped from surveys chiefly non-topographical, and of which in many places the basis consists to a great extent of disconnected land-office and property plans, are shown by the tint next in density; the next lightest tint (3) represents the parts of the world that are only mapped from route-surveys or rough traverses of explorers. Although these traverses vary greatly in degree of accuracy, they cannot be considered so reliable as the surveys shown by either of the other two shades, and in many cases the mapping consists of the roughest sketches. (4) The regions that are entirely

unsurveyed and unmapped are indicated by the lightest tint of all, almost white.

Before dealing with the present-day map, I desire to call attention to the 1860 map. Referring to the state of surveys in the Eastern Hemisphere in 1860, it will be seen at once that outside the continent of Europe, where a considerable extent of accurate surveying had been carried out, the only country where any mapping, based upon triangulation, had been done was India. These areas are shown in the darkest shading. In Europe France, the British Isles, Germany, Austria, Italy, Russia, Switzerland, Denmark, the Netherlands, and Scandinavia had already made a good commencement with their Government maps based upon trigonometrical surveys, but these were in several cases by no means complete, and it is interesting to note that even of Scotland there existed at that time no Ordnance Survey for the northern part. The southern part had been surveyed and mapped on the 1-inch scale long before this, but the survey was afterwards carried on in England, and, later on, on the 6-inch scale in Ireland, so that the northern part of Scotland was not done in 1860. India has been noted for the excellency of its surveys ever since the days of Major Lambton, who started the work in 1804, and Colonel Everest, who succeeded him as head of the surveys after Lambton's death in 1823. As will be seen, in 1860 a considerable extent of India had been mapped from trigonometrical surveys. Even before Lambton's time India had been well ahead of any other country outside Europe with its surveys, which was entirely due to the energy and skill of Major James Rennell, who as Surveyor-General of Bengal surveyed the Ganges and lower Brahmaputra rivers, as well as the districts of Bengal, with Behar, between 1763 and 1782.

In the parts of the Eastern Hemisphere that were surveyed and mapped in the second degree of accuracy according to our system, that is, those shown by the next tint, may be included most of the remaining parts of Europe, Egypt, and parts of Algeria near the coast. For the rest such mapping as was done was based upon rough route-sketches, shown by the third tint. In this must be included practically all that was known of the African continent, such as the explorations of Mungo Park, Beke, Livingstone, Speke and Grant, and others, as well as the early exploratory surveys in Central Asia and Australia. The regions that were entirely unsurveyed and unmapped at this time were, as you see, enormous in their extent, and included not only the Polar regions, but vast areas of Central Africa, Asia, and Australia.

Turning to the Western Hemisphere, we find that at this date no triangulation of any extent had been carried out. The U.S. Coast and Geodetic Survey had made a good start, but their work had been confined to the coast-line or districts near the coast. There had been La Condamine's attempt at measuring an arc of the meridian near Quito in South America in 1736, the measurement of the Mason and Dixon line, and their survey of the boundary between Pennsylvania and Maryland, in the latter part of the same century; but neither of these resulted in any serious topographical mapping. Such surveys as existed of the interior parts of the United States in 1860, although they varied as regards their merits and degree of dependence, could not be considered as anything but approximate. Some parts of the eastern States are, as you see, shaded with a tint of the second density, but, with this exception, such mapping as had been done either in North or South America cannot be considered of a higher order than route-traversing and sketching, and is tinted accordingly.

Vast areas of Central Asia, and a still larger portion of the interior of Africa, were entirely unmapped in 1860, as was also the case with South America away

from the courses of the great rivers, North America and the Arctic regions. Attempts had been made to penetrate and traverse the desert-like interior of Australia, but to a great extent this region was still entirely unmapped. Several important expeditions had commenced the exploration and mapping of the coast-line of the Antarctic continent, such as that of Captain James Ross, who had penetrated a considerable distance south in the neighbourhood of South Victoria Land, and Captain Wilkes and others, who had sighted land to the west of this region. But, after all, little had been done in the way of surveying and mapping in the Antarctic Regions.

Referring now to the 1916 map on which the same shades of tints have the same meaning as on the previous map, you will see at once that the parts that are accurately surveyed from a topographical point of view, based upon triangulation or rigorous traverses, have greatly increased in extent, and these now represent, according to a rough estimate I have made, about one-seventh of the total area of the land-surface of the Earth, instead of only one-thirtieth, as was the case in 1860. Remarkable progress has also been made with regard to both of the less accurate kinds of surveying and mapping, while the parts that are now entirely unsurveyed and unmapped only amount to about one-seventh instead of a little over one-half, which was roughly the amount in 1860.

I have attempted to form an estimate of the condition of the world's surveys as represented by the differently tinted areas on the maps for 1860 and 1916; and, taking the total area of the land-surface of the Earth, together with the unknown parts of the Arctic and Antarctic regions, which may be either land or water, to be 60,000,000 square miles, I have obtained the following results :—

	1860. Sq. stat. miles. Proportion to whole.	1916. Sq. stat. miles. Proportion to whole.
1. Mapped from accurate topographical surveys based on triangulation or rigorous traverses	1,957,755 = 0·0326 or roughly $\frac{1}{30}$	8,897,238 = 0·1482 or roughly $\frac{1}{7}$
2. Mapped from less reliable surveys, chiefly non-topographical	2,017,641 = 0·0336 or roughly $\frac{1}{30}$	5,178,008 = 0·0866 or just over $\frac{1}{12}$
3. Mapped from route traverses and sketches	25,024,360 = 0·4170 or roughly $\frac{2}{5}$	37,550,552 = 0·6258 or little less than $\frac{2}{3}$
4. Entirely unsurveyed and unmapped	30,997,054 = 0·5166 or just over $\frac{1}{2}$	8,350,794 = 0·1391 or little less than $\frac{1}{7}$

These proportions can perhaps be more clearly seen from the diagram given on the back of the 1916 map, and on which numbers and tinting have the same significance as on the maps and table.

From the figures here given it is plain that with the same rate of progress as that of the past sixty years or so it would take just over four hundred years more to complete the accurate trigonometrical surveying and topographical mapping of the Earth's land-surface, including the parts of the Polar Regions that may possibly be land—that is, the 60,000,000 square miles which we have taken for this total area; but this will certainly not be the case, since the rate at which such surveys have been carried out has been greatly accelerated during recent years, owing to the rapidly increasing demands for accurate topographical maps, improvements in methods, and other causes, so that it will possibly not be half this time before all the parts of the Earth's surface that are likely to be of any use to man as settlements, or capable of his development, are properly

surveyed and mapped. There are, of course, regions, such as those near the Poles and in the arid deserts, that are never likely to be accurately triangulated and mapped to any extent, and it would be mere waste of time and money to attempt anything of the kind.

As might be expected, the parts of the Earth's land-surface that are accurately surveyed, about one-seventh of the whole, are those inhabited by the most civilized nations and their dominions. The areas so mapped include the European countries (with the exception of some parts of the Balkan States), India, Japan, Algeria, Tunis, Egypt, and other parts of Africa under the dominion of European nations, United States, parts of Canada and Mexico, the international boundaries between some of the South American countries, and very restricted areas of Australasia. These have all regular Government topographical surveys based on accurate triangulation, and are therefore shown in the darkest shade on the map. The parts that are still unsurveyed and unmapped in any sense are, as will be seen, certain remote unexplored regions near the Poles, a few patches in Central Asia, much of the interior of Arabia, parts of the Sahara, and certain other comparatively small areas in Central Africa, a considerable amount of the interior of South America, specially those parts between the great rivers, and certain areas of the interior of Australia. These are shown by the lightest shade on the map, and at the present day represent slightly less than the area that is accurately mapped. Between these two extremes the surveying and mapping varies in merit and degree of reliability from that of a fairly accurate nature, such as land-office plans (which as a rule make no pretence at showing topographical features) and the more accurate plane-tabling and compass-traversing, which altogether may be taken as covering about one-twelfth of the Earth's land area, and that enormously extensive area only roughly mapped from route-traverses of explorers and others, which now constitutes about two-thirds of the whole of the Earth's land surface.

Many and varied have been the influences that have led to the surveying and mapping that have already been accomplished, and it would be interesting if we had time to analyze them. Among the preliminary surveys, I think it would be found that military operations would hold an important place. Many an unexplored region has been mapped for the first time as the result of frontier expeditions, such as those of the frontier regions of India and parts of Central and South Africa, while the need of a more exact acquaintance with the topographical features for military requirements have frequently led to more exact trigonometrical surveys. Our own Ordnance Survey is indeed an example of this, for in the first place it resulted from the military operations in Scotland in the eighteenth century.

Among other causes that have resulted in surveying and mapping might be mentioned the delimitation of boundaries, commercial or industrial undertakings, such as gold-mining and land development, projects for new railways, all of which have at times been fruitful in good cartographical results. Nor must we forget Christian missions, for the better-trained missionary has always recognized the importance of some sort of a survey of the remote field of his operations, and the route to it. We have only to think of such men as Moffat, Livingstone, Arnot, Grenfell, and others of the same sort, to be reminded of the debt due to the missionary from all interested in geographical mapping.

Still, few of the expeditions referred to so far have had surveying as their primary object, and such mapping as has been carried out has been incidental and necessary for the prosecuting of the main purpose in view. Properly

equipped surveying expeditions that have been despatched from this and other countries have during recent times added enormously to our knowledge of the surface configuration of the Earth.

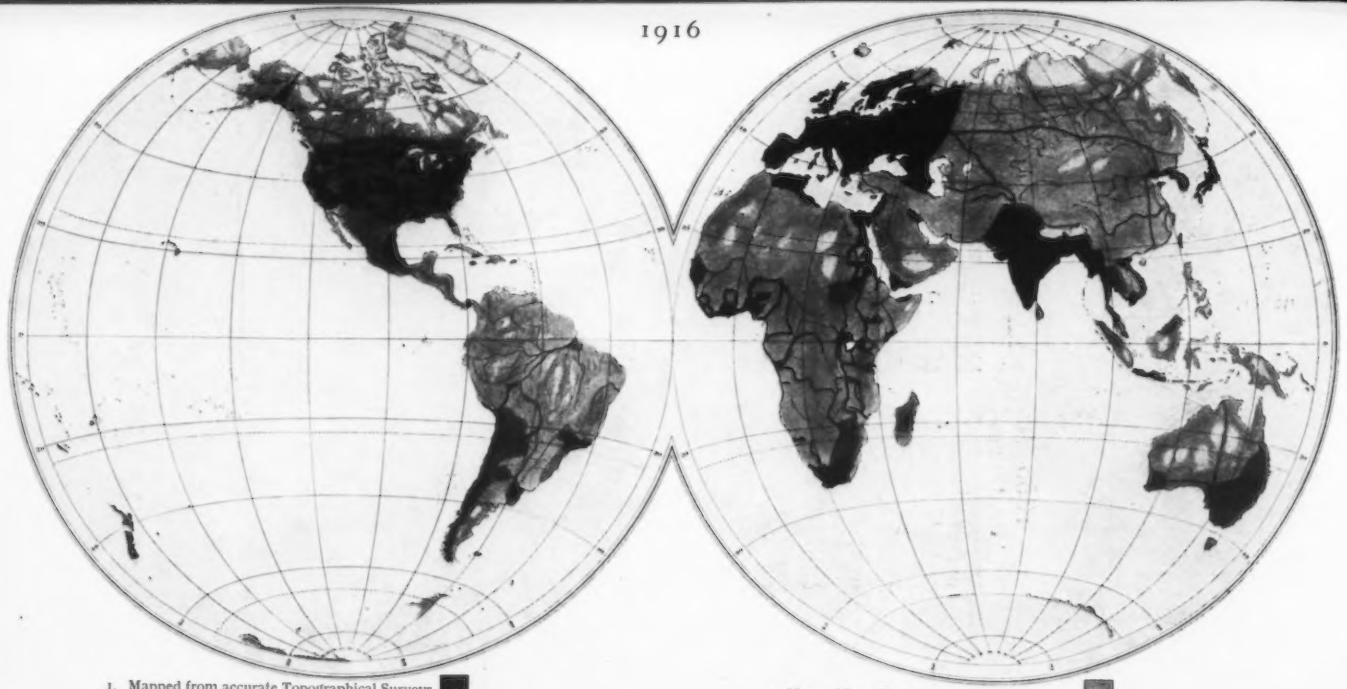
The survey of British possessions in Africa and other parts of the world under the Colonial Office have recently made rapid progress, and full particulars of the work done are given from year to year in the Annual Report of the Colonial Survey Committee, which was first published in 1905. These reports, accompanied by plans and diagrams, contain most valuable information and show exactly what has been done, the method employed, cost of surveys, etc. All who are interested in these matters would be well repaid by a careful perusal of these valuable publications, which cost only a few shillings.

From its very foundation the Royal Geographical Society has had a remarkable influence on the surveying and mapping of the Earth's surface, and especially those parts of it which have been previously but very imperfectly known or entirely unexplored. I think it must be admitted that this influence has increased as years have gone by, and it is no exaggeration to say that it has done more in this respect than any other body. It is therefore perhaps fitting that I should give some account of what has been accomplished, as it has a direct bearing on route-surveying and mapping by travellers and explorers. It is not only by the awarding of annual medals to explorers whose journeys have resulted in an increase to our geographical knowledge, and the more accurate surveying and mapping of little-known parts, that the Society has stimulated and encouraged geographical research, but it has also assisted financially numerous expeditions, and the money thus granted has enabled many a man to carry out his explorations to a successful issue, which he otherwise could not have done for the want of funds. Still more frequently has it been the case that travellers going into little-known parts of the world have been granted loans of surveying instruments which they could not otherwise have taken, and encouraged to do what mapping they found possible. Altogether 331 expeditions have borrowed instruments, and about £38,500 have been devoted to grants of money by the Society to further geographical exploration and surveying.

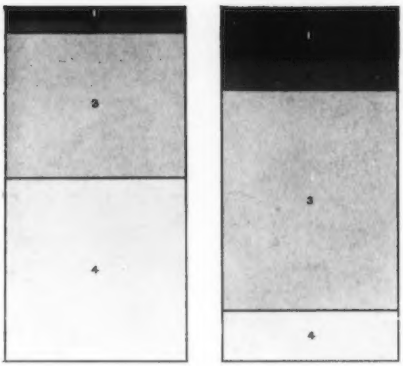
There is still another way, by no means the least important, in which the Royal Geographical Society has done much to promote geographical surveying, and that is by providing suitable instruction in the work of surveying for travellers. It is all very well to grant money and lend instruments, but the important thing is to know how to make good use of the money and the instruments lent so as to take proper advantage of opportunities afforded and to do the best surveys and maps of the regions visited. In the early days of the Society a man had to pick up the requisite knowledge as best he could ; but in 1879 a scheme of proper instruction was started at the suggestion of the late Sir Clements Markham, who was then one of our Honorary Secretaries. This had small beginnings, but in recent years has made rapid strides, until at present it forms one of the most important parts of the Society's work. This course of instruction in geographical surveying, which has now been in existence for about thirty-eight years, was first conducted by my predecessor, the late Mr. John Coles, and, since he resigned in 1900, has been under my charge. Altogether 725 surveyors and explorers have received instruction, without reckoning special large classes of forty or fifty men which during the past few years, until the outbreak of war, have been sent to us by the Colonial Office to learn the more elementary parts of compass-traversing and mapping.

Now as regards the future. The demand for properly trained geographical

1916



1. Mapped from accurate Topographical Surveys
2. Mapped from Less Reliable Surveys (chiefly Non-Topographical)
3. Mapped from Route Traverses and Sketches
4. Entirely Unmapped . . . . . .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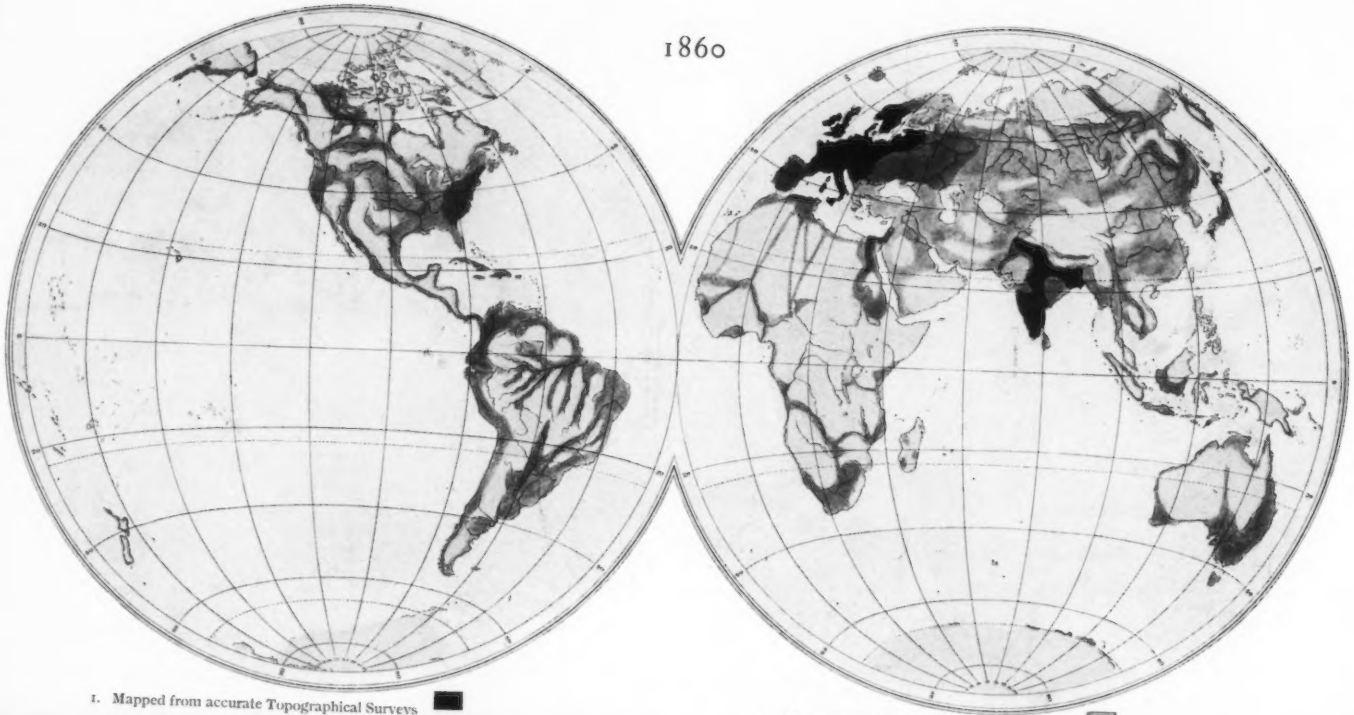
1860



1. Mapped from accurate Topographical Surveys
2. Mapped from Less Reliable Surveys (chiefly Non-Topographical)
3. Mapped from Route Traverses and Sketches
4. Entirely Unmapped . . . . . .

surveyors has been steadily increasing in past years, and is likely to be still greater as time goes on. After the termination of the war there will be much work to be done, especially as regards the surveying of new boundaries, and freshly acquired districts in Africa and elsewhere; and it would be wise to make preparations for this well ahead.

The future surveyor will be in a much better position than his predecessors, not only on account of the improvements in instruments and apparatus for his work, but because, in many parts, a good beginning has been made with the triangulation to which the new surveys can be adjusted. In Asia a considerable amount of new work of this kind has been done over the frontier of India in recent years by the Survey of India, among the more important of which is the connecting of the Indian triangulation with that of Russia by way of the Pamirs, the surveys of Sir Aurel Stein, Dr. de Filippi and others. The many boundary surveys that have been carried out in Africa, the triangulations of Egypt, the Sudan, East and South Africa, and other parts of the continent are well advanced, and will be of the utmost value to the future surveyor. One of the most important lines will be the great triangulation which, it is hoped, will some day run across the continent from south to north, from the Cape to Egypt. Owing to the energies of the late Sir David Gill this important chain of triangles has already got as far as the southern end of Lake Tanganyika; the part to the west of Uganda near Ruwenzori has also been finished, and it now remains to carry the chain through German East Africa and down the Nile Valley. The latter, it is hoped, will by degrees be accomplished by the Sudan and Egyptian Survey Departments, although it may be delayed for some years yet; and the former, which was to have been undertaken by the Germans, it is to be hoped will after the war be accomplished by British surveyors, through—not German East Africa—but newly acquired British territory. Running right through parts of Africa that are but imperfectly mapped in many districts, the stations of this triangulation will be invaluable for the adjustment of any network of triangulation for future surveys in the interior, and, indeed, has already been utilized for the purpose.

The carefully-carried-out boundary surveys between various countries of South America will be of the greatest assistance in future exploration and survey in the interior of that continent, wherever they are available, while the Survey Departments of Canada and the United States are doing excellent work and extending their surveys far into the imperfectly mapped regions of North America. So, altogether, the surveyor of the future will soon have a good foundation of reliable points to work from. It is important to remember that running a chain of triangles across a country, though important as a framework, does not constitute a map of the country; what is wanted is a series of good topographical maps, based upon triangulation, showing the leading features with sufficient accuracy for the purposes of ordinary mapping, so that on the scale of 1 : 250,000, or even 1 : 125,000 there is no appreciable error.

As regards instruments, the Astrolabe à Prisme is being increasingly used for taking equal-altitude observations with most excellent results, but at the present time the 5-inch transit micrometer theodolite, already referred to, is perhaps all that is required for general work. It has now been thoroughly tested and found most satisfactory. As regards smaller instruments, there is the 4-inch tangent-micrometer theodolite, and for rapid exploratory survey, where weight is a great consideration, a little 3-inch theodolite has been found useful.

For baseline measurement the invar tape should be taken on all serious

1. Mapped from accurate Topographical Surveys
2. Mapped from Less Reliable Surveys (chiefly Non-Topographical)
3. Mapped from Route Traverses and Sketches
4. Entirely Unmapped

work, and for filling in the topographical features a good plane-table is doubtless the instrument to use. In mountainous regions and in some other special conditions photographic surveying doubtless has a future before it, and in military operations when the photographs are taken from aircraft it has proved itself invaluable ; but in ordinary surveying it is, I think, not likely to take the place of well-established methods. The introduction of wireless telegraphy for the determination of longitude is likely to increase in usefulness. Good examples of the work done with it have lately been given in the *Geographical Journal* and elsewhere.

Time does not permit of my going more fully into this subject, and I must now bring this address to a close.

REVIEWS.

EUROPE.

Bibliography of Yorkshire Geology.— (C. Fox-Strangways Memorial Volume.) **T. Sheppard.** London, Hull, and York : A. Brown & Sons. 1915. 15*s. net.*

THIS well-nigh exhaustive list of books and papers on Yorkshire geology is issued as Vol. 17 of the *Proceedings of the Yorkshire Geological Society*, a body which has itself done not a little to further the knowledge of the subject in question. Its basis is an incomplete MS. list compiled by the late C. Fox-Strangways for the years 1534–1892, but this has been revised and extended by the present author, who has also completed the work by adding the entries for 1893–1914—no small proportion of the whole. Mr. Sheppard is known as an enthusiastic worker in this field, and has devoted five years of assiduous labour to the task, with the result that we have as complete a guide to the literature of the subject as can exist for any part of the British Isles. He has worked through an immense number of serial publications likely to contain papers on Yorkshire, whether primarily devoted to geology and physical geography or of a more general character, and the mere list of their titles (including a fair proportion of foreign scientific serials) occupies twenty pages. Help has also been accepted from previously attempted lists of a more restricted scope than the present, of which help full acknowledgment is made in the Introduction. The bibliography itself, extending to 500 pages, is not classified by subject, but is arranged chronologically, the arrangement within each year being alphabetical by names of authors. But the very full and complete index supplies an ample guide to the individual subjects treated of, besides including all authors' names in one and the same alphabet. Perhaps the only defect to be noticed is the failure to give any indication of date at the head of the pages. The omission is somewhat irritating, as the year appears only, as a rule, at the *beginning* of each annual list. Mr. Sheppard is to be congratulated on the successful completion of an arduous and most useful task.

With Gypsies in Bulgaria.— Andreas (Mui Shuko). Liverpool: Henry Young & Sons, Ltd. 1916. Pp. vii. and 141. *Map and Plates.*

The anonymous author of this book was in Varna on holiday at the end of May, 1913, when Bulgaria began that secret mobilization which led to her treacherous attack upon her former allies, and her subsequent defeat. As his time was limited, and he was unwilling to be detained indefinitely in Varna, he made up his mind to attempt to reach Rumania by travelling as a gypsy with

a band of gypsies. He speaks of his costume as a disguise, and of the journey as an escape; but it does not appear that anything but personal choice influenced the particular mode of travel adopted, for he had friends and passports, and could, it may be supposed, in the absence of passenger trains, have travelled in his own dress on foot or by carriage. We gather, however, that he is particularly interested in gypsies, and that part of the object of the journey was to acquire further acquaintance with them and their ways.

The party with which he travelled were Christian gypsies, by profession theoretically comb-makers, but really horse-stealers, horse-stealing among Bulgarian gypsies being an honourable and lucrative but dangerous occupation. The journey was from Varna to Ruschuk on the Danube, *vid* Razgrad, and of it the author gives a very entertaining description. The description, however, is concerned far more with the ways and manners of the gypsies than with the country passed through, which the author found monotonous, depressing, and very scantily peopled. The dress, dwelling-places, utensils, and furniture of the gypsies are very carefully described, the author showing great sympathy for these wanderers, and much appreciation for their mode of life, which he is now apparently practising, in a somewhat modified form, on the fields of Flanders. His admiration for the gypsy virtues naturally makes him a little scornful of the settled peasants of the region traversed, and he is strong on the persecution of the "poor Roms" throughout Europe generally, by those who are unwilling to take the loss of horses, fowls, and movable property generally with due philosophy.

A similar instinct leads him, like so many outsiders, to laud the virtues of the Turk as against the other inhabitants of the peninsula, as is well seen in the following characteristic passage: "Under Ottoman Government every Balkan town, no matter how insignificant, had its public *hammam*, every house its private bath. . . . Following the advent of Christian rulers in the Near East, cleanliness, an easily dispensable adjunct of Christianity, gradually vanished and godliness with it. . . . In Razgrad the bath still occupies a central and conspicuous position in the old Turkish town, where its simple yet stately architecture is a fitting memorial of Turkish virtues which Bulgarians have jettisoned in the pursuit of what they flatter themselves is progress. In revenge they have built on the heights, as a utilitarian emblem, a commonplace modern school of large dimensions, whose many windows gape without sympathy or understanding at the monument of idealism below." There are many similar passages, notably a charming one describing the fountains erected by pious Turks in hollows on the hot and waterless plains. One need not perhaps take too seriously either the author's implied sympathy with horse-stealing as an occupation or his professed admiration of the Turks as rulers, but his book, which can be read in an hour, may be cordially recommended as a supplement to more ambitious studies of Balkan questions. It is singularly fresh and interesting, and quite unpretentious.

M. I. N.

ASIA.

A New Account of East-India and Persia.— John Fryer, 1698. Edited by **William Crooke, B.A.** Three vols. London: Hakluyt Society. 1909–15. *Illustrations.*

John Fryer, a young Londoner who had just obtained a medical degree at Cambridge, was engaged by the East India Company in the autumn of 1672 to act as surgeon at Bombay. He sailed early in the following year, and returned to England in August, 1682, after an actual residence in India of about

seven years and in Persia of one and a half. His experiences in both countries were narrated at the time in a series of eight letters addressed to a friend or patron in England; and these, considerably revised, were given to the world in 1698 under the title recorded above.

The work became deservedly popular, and it is somewhat surprising that, except for an early Dutch translation and a partial reprint some forty years ago, no attempt has hitherto been made to render it generally available. It is true that Fryer saw nothing of the interior of India, and in this respect his book suffers in comparison with the narratives of Bernier, Tavernier, and Manucci; but he gives a full account of the western coast, particularly of the English settlements there, and he displays a special interest in the animal and vegetable products of the country. His description of Persia is also valuable, although his travels were confined to the well-worn track between Bandar Abbas and Isfahan. His style, obviously modelled upon that of Sir Thomas Browne, is turgid and ornate; but this only reflects the character of the writer, who seems to have been very much alive to his own importance. That does not, however, detract from the interest of the volume, which is full of shrewd and accurate observations.

The edition now produced by the Hakluyt Society is thoroughly satisfactory. All the original plates are given (on a slightly reduced scale); and the annotations of the learned editor provide all necessary assistance in the comprehension of the text. The full index is particularly welcome, since the original attempt in that direction (also included) is more quaint than useful. W. F.

Armenia: Past and Present. A Study and a Forecast.— W. Llew. Williams. With an Introduction by **T. P. O'Connor, M.P.** London: P. S. King & Son, Ltd. 1916. Pp. xi. and 211. *Two maps.* 3*s.* 6*d.*

This little book is in essence a plea for the establishment, at the end of the war, of an autonomous Armenia, to include the six vilayets of Bitlis, Diarbekir, Erzerum, Kharput, Sivas, and Van, with Adana or Cilicia in addition, in order to give the State an access to the sea. Details in regard to the proposed state are not discussed, beyond the suggestion that it should be put "under the immediate protection of the Allies, with Russia as their mandatory." The volume is divided into three sections, the first being entitled "The Land and the People," and containing accounts of the geography, ethnology, and resources of Armenia, based chiefly upon Lynch and other writers. The second section is historical and is also based chiefly upon Lynch, the *Encyclopædia Britannica* article, and other similar sources, while the third section deals with the Armenian problem as it presents itself to-day. Of the two maps one shows the ancient kingdom of Greater Armenia, and the other the proposed autonomous Armenia. Based as it is upon the ordinary works of reference which deal with Armenia, the book will add little to the knowledge of those who have already made any study of the subject, but as a work of popularization it will no doubt fill a useful place. M. I. N.

AMERICA.

Bulletin of the Seismological Society of America. Vol. 5. 1915. Stanford University Press, Cal.

The Seismological Society of America has now 351 members. Its *Bulletin* is published quarterly, the volume for the past year containing about 250 pages,

and including several papers of more than local interest. Some of the papers, however, show a want of acquaintance with the work already done in foreign countries. One of the leading members, for instance, discusses the untrustworthiness of personal impressions of the direction of earthquake-vibrations. His conclusions with regard to such impressions and the measured directions of overthrow of objects are correct, but it is now well known that the average of a large number of observations of either kind agrees very closely with the true direction of the shock.

The most valuable papers are those which contain the result of special earthquake-studies. In the State of California, which is the most active district in the United States, several important earthquakes have recently occurred. Mr. E. F. Davies describes the earthquake of 8 November 1914 in central California, and shows that its epicentre is close to the San Andreas rift. It was to movements along this rift, extending for a total distance of 290 miles, that the San Francisco earthquake of 1906 owed its origin. Seven months later, on 22 June 1915, two earthquakes, almost as violent as the last-named, occurred in the Imperial Valley, Southern California. These earthquakes, as Mr. C. H. Beal shows, originated probably in movements of the San Jacinto fault, itself apparently a branch of the San Andreas rift. About 20 miles to the north-east of the latter rift there runs a parallel fault known as Hayward's rift. Mr. E. F. Davies suggests that the earthquake of 7 October 1915 was connected with a movement along the northern end of this rift.

C. D.

GENERAL.

Men of the Old Stone Age: Their Environment, Life and Art.— Henry Fairfield Osborn. London: G. Bell & Sons. 1916. 21*s*.

Dr. Osborn, the well-known director of the American Museum of Natural History, Professor of Zoology in Columbia University, honorary Doctor of Science of Cambridge, the successor as Palæontologist to another great American man of science, Cope, has written a very interesting work on the ancient peoples of Europe from the remotest times to the commencement of the Neolithic period. Prof. Osborn has long been preparing for this task. Nearly two years ago I visited him at the Museum in New York and saw there the modelling of the "portraits" of prehistoric Man which were being prepared under his directions, devised of course from as careful an analysis as possible of skull form. He had previously made a tour through the principal cavern regions of South-Western Europe, guided by expert archæologists. The volume which is the outcome of these researches and studies will, I think, be held everywhere as an illuminating and in some respects conclusive treatise on ancient Man.

Experts may differ from Dr. Osborn in regard to his chronology, and we have not as yet sufficient data to be absolutely dogmatic on the subject. He tends to lessen the estimate given by some geologists as to the extent in time through which may be traced back the history of Man (or of beings that were nearly men) in Europe; and likewise the length of time covered by the succession of Ice Ages and their warm or temperate intervals. He does not place the oldest human fossil of Europe at a much greater distance from the present day than 500,000 years, and is sceptical as to the value of eoliths, that is to say, of those stone fragments that may have been used by hominids, but could scarcely be called artefacts, and which might equally well have been produced by other forces than the hand of Man.

Briefly summarized, his theories are that the human family or sub-family

arose from the anthropoid ape not within the limits of Europe, but somewhere in Asia; and that Europe has seen a succession of human invasions from Asia (principally) and at a later period from North Africa. On the other hand, the peculiar human species known as *Homo neanderthalensis* probably originated in Europe from an early hominine, which may equally have been the ancestor of the Piltdown man and of *Homo sapiens*. He ranks the Trinil skull of Java (*Pithecanthropus*) as nearest of all discoveries to "the missing link." The Piltdown skull he places comparatively late in time, as having existed at a period not much more than 100,000 years ago. In this direction, as in the final note of his appendix, he seems to go wide of the evidence, and even to be a little perverse in quoting the absurd suggestion made by Mr. G. S. Miller of the United States National Museum, that the Piltdown jaw and tooth do not belong to the Piltdown calvarium, but to a species of chimpanzi which is assumed to have lived in Sussex 100,000 years ago. Mr. Miller's only excuse for such an assumption is that a molar tooth of Pleistocene age found at Taubach in Germany, and hitherto regarded as human, strikes Mr. Miller as being much more like the molar of a chimpanzi. On this very debatable point he erects a theory that a chimpanzi lived in Europe during the human period and may have penetrated to Sussex, and by one of the most extraordinary coincidences ever known, had its lower jaw and canine tooth washed by a flood into close proximity (a yard or two distant) with the skull of an early type of human being.

This quotation from Mr. Miller is the only weak point in the work under review, which places before us as has never yet been done the remarkable achievements of the Cro-magnon race in Europe and North America, and generally brings into focus better than in any previous book all the evidence at present available as to the history of early Man in Europe.

H. H. JOHNSTON.

THE MONTHLY RECORD.

EUROPE.

Annual Report of the Ordnance Survey, 1915–16.

THE Annual Report of the Director-General shows that while the work of revision was necessarily much reduced, and the publication of new sheets to a large extent postponed owing to the pressure of more urgent work, it has been possible to carry on the recently instituted geodetic levelling in the intervals of other duties. One of the lines levelled during the year under consideration has a special interest, because it was a line levelled for the British Association under the general direction of Dr. Whewell seventy-eight years ago, between the Bristol Channel and the English Channel. Four of the original six marks were identified, and the difference between the early and the recent results is 1·12 inches in a length of 58·7 miles. The calculated probable errors of the two operations are 1·88 and 0·17 inches respectively; hence they agree within the limits of their probable errors, and there is no indication of any tilt of the line during the past century. It is a matter for congratulation that the spirited enterprise of Dr. Whewell has now received due recognition by the Ordnance Survey, and that so interesting a result has been arrived at in the course of the year's work. Since the beginning of the new geodetic levelling 1800 miles have

been covered, with a probable error of less than ½ mm. per km. as against the standard of 1 mm. per km. laid down by the International Geodetic Association for levelling of high precision. Two of the three tidal observatories are now in regular work, and the first results are given in the report in the form of monthly means of the mean sea-level and barometer, covering three years for Dunbar and one year for Newlyn. The Magnetic Survey was continued up to the end of August 1915, when the observers were withdrawn, leaving seven stations still to be visited. The considerable part which Geodesy now plays in the Annual Report of the Ordnance Survey is very gratifying to scientific geographers, especially in view of the need which must arise in England for some form of Geodetic Institute and Laboratory to serve the requirements of the Empire. Whether a school of geodesy should be attached to the Ordnance Survey, or to the National Physical Laboratory, or to one of the Universities, is, we believe, under consideration at the present moment. Whatever might be its organization, it is at any rate certain that any geodetic work in England, such as the much-desired gravity survey, could not be done without the co-operation of the Ordnance Survey. The recent magnetic survey shows how much may be done at relatively small expense when the survey and a scientific society join forces. We look to a great extension in the future of the policy so well initiated by the Royal Society and Colonel Close.

The Floating Fen of the Danube Delta.

A paper by Miss Marietta Pallis on this subject, read on 16 December 1915 before the Linnean Society, and since printed in its *Journal* (vol. 43, No. 291, 1916), will be read with particular interest at a moment when all eyes are turned to that region by reason of its inclusion among the theatres of active operations in the present war. Miss Pallis, who has for some time been known for her studies in the Norfolk Broads (on which she read a paper at an Afternoon Meeting of the Society in 1910; see *Journal*, Feb. 1911), visited the Danube delta in the autumn of 1912 with a view to gaining some knowledge of similar localities and their vegetation for comparative purposes. The fen of the Danube, locally known as *plav* ("floating"), is formed almost entirely of living reed (*Phragmites communis*), and in structure and origin is closely allied to the fens of East Anglia. In Rumania *plav* is practically confined to the delta of the Danube, where its distribution is wide though sporadic. Miss Pallis received much courtesy and assistance from officials and natives, especially the local fishermen of all races. She mentions particularly the help rendered her by Dr. Antipa, author of the one previous work describing the *plav* in any detail, whose map of the region she reproduces, making use also of his topographical description of the Rumanian *Balta* or inundation district of the Danube, through which she travelled extensively in the course of her researches. It includes useful details as to the periodic floods and the way in which the water is distributed through the lakes connected with the river according to the height of the flood, and the varying elevation of the lake bottoms and of the banks which border them. While the whole flooded area, both of the river-valley and of the delta, is known as the *Balta*, there are important differences between the upper and lower portions. In the former, which is subject to high floods, much silt is deposited and there are many temporary and shallow lakes. It is a region of willow-forest, of pasture, of reed-thicket or permanent reed-swamp, but *plav* proper is absent. In the delta the silt deposit is slight and the lakes are for the most part permanent and deep; it is a primitive region almost entirely covered by permanent reed-swamp and *plav*. Its floor is on an

average from 6 to 9 feet below water-level of the Black Sea, and its water-surface (relieved only by a few embankments, shoals, and islands—the *grinds* of the fishermen) is divided up into separate lakes by the encroaching reed-swamp. The paper enters fully into the method of growth and extension of the reed composing the *plav*, which differs in some ways from the reed of East Anglia, and may be considered a variety of the same species. An excellent series of photographs illustrates the structure and form of the reed masses, both below and above water. *Plav* is found to be built up almost entirely of *vertical* reed-rhizomes, which with the aid of their roots retain much soil. It is formed by the detachment of the reed from the firm ground at a more or less definite stage of its growth, probably by the agency of changes of water-level or of storms. It is necessary that the water be deep enough to prevent the reed filling it completely and that the silt deposit be small.

AFRICA.

Hypsometry of the Basin of Timbuktu.

The morphology of the region stretching north of Timbuktu and the Middle Niger offers some of the most interesting problems still to be solved in the physical geography of Africa. Although so far from the coast, the altitudes in this region are relatively low, and the depressed area of the Juf has even been supposed to be below sea-level. This is now known to be a mistake, but it has at least been established that the Juf is the lowest depression of this part of the Sahara, lying not many hundreds of feet above sea-level. The determination of altitudes in this region is of great interest in connection with the former hydrography, which was probably very different from that of the present day, but of which the determination is specially difficult in a desert region where the conditions of erosion are abnormal. The French geologist, M. Chudeau, whose researches have thrown much new light on the past and present geography of the Sahara, has shown good reason for supposing that the Niger once followed a more northerly course, continuing in that direction from a point west of Timbuktu instead of making its pronounced bend to the east. M. Chudeau has given the latest results of his studies in papers printed in *La Géographie* for December 1915, and in the *Annales de Géographie* for May of this year. Both papers deal with the general morphology of the region, but the second is specially concerned with the altitudes and their method of determination. While using all the available observations, both of other travellers and himself, he pays special attention to the necessary corrections to be introduced, pointing out the defective results obtained when due account is not taken of the horizontal distance between the station of observation and the station of known altitude used for comparison of the barometric data. His results therefore inspire considerable confidence. Applying them to the general morphology of the region he shows that there are few ranges of mountains, but that the characteristic features are plateaus which end abruptly in escarpments often running continuously for long distances. The general fall, as shown by his hypsometric sketch-map, is from east to west. On the east the region adjoins the elevated mountain tract of Adrar of the Iforas, over 500 metres in altitude, though separated from it in the south by the north to south line of depression of the Tilemsi. Westward the ground falls to the lower grounds of the Azauad and the Juf—the latter less than 150 metres above the sea in its known eastern section. (That it now forms a closed basin is proved by altitudes determined further west in the direction of Mauretania.) M. Chudeau draws a hypothetical contour of 250 metres (20 metres below the

altitude of Timbuktu as now established) running generally north and south from Lake Fagibini to the Juf, in accordance with the supposed ancient course of the Niger in this direction. But positive data for its establishment are still wanting. The old drainage of the region under discussion seems to have been carried west-south-west towards this old course of the Niger, the principal artery being apparently the Wed Tamanranset, whose bed is thought to be traceable at various points on the itineraries of travellers. But the direction of its slope is still a matter of uncertainty, and even if it should be proved to take an opposite course at the present day, this would be no proof that the same was the case in ancient times, as the absence of effective erosion permits the reversal of former directions of flow even by slow and gradual tectonic movements.

AMERICA.

Phosphate Discovery in Canada.

Phosphoric acid, as is well known, is one of the principal ingredients of plant-food necessary for the successful prosecution of agriculture, and the question of its future supply is a pressing one, given the rate at which the natural supply in the wheat lands of Canada and other new countries is being depleted by continuous cropping. It is calculated that half a million tons of high-grade phosphate rock would be required annually to offset the waste from land already under cultivation in Central Canada. Important beds of phosphate rock (phosphate of lime) have been brought to light within recent years in the Rocky Mountain region within the United States (Montana, Idaho, Wyoming, and Utah), and, forming as they do the largest known area of phosphate beds in the world, are bound to supply a large part of the whole production of commercial fertilizers. The beds occur at a definite geological horizon near the top of the Carboniferous system, and though not extending continuously north to the Canadian border it was evidently important that a careful search should be made for their occurrence in the Canadian Rockies, in Alberta and British Columbia, where, after an interval occupied by older rocks, the Carboniferous series was known to reappear. The task was undertaken by the Commission of Conservation, and the first results are described by Messrs. F. D. Adams and W. J. Dick in a report issued by the Commission in 1915. In accordance with the supposed distribution of the Upper Carboniferous, three lines of section were carefully examined. Along the first, that of the north Kootenay Pass, it was found that Dawson's view of the stratigraphical succession was not substantiated, and that there were no rocks of Carboniferous age. In the Turtle Mountain district of Alberta, too, the Carboniferous rocks were too low down in the series to contain phosphates, but along the third section they proved to show a succession closely resembling that in Montana, and encouraged the belief that phosphate rock would be found. A search was made in the bed of Forty-mile Creek, in the Rocky Mountain Park at Banff, this stream three times crossing the beds in which its occurrence was anticipated; and the search was rewarded by the discovery of a large mass of compact phosphate rock, the only variety which could survive violent attrition in a turbulent stream. Analysis has shown this rock to contain 53·95 of phosphate of lime, and as other indications of the presence of phosphate or phosphoric acid in the rocks of this region were discovered, the prospects of the discovery of workable deposits seem good, particularly as the formations in question are continued both in a north and south direction. At present, apart from the United States, the largest producers of phosphate rock are Tunis and Algeria,

Christmas Island in the Indian Ocean, with Nauru and other islands in the Pacific.

The Bay of San Blas, Panama.

The President of the Republic of Panama, Señor Don Belisario Porras, has kindly sent to the Society an interesting account of a ten days' excursion in a small steamer to the numerous little-visited islands and the Bay of San Blas in the neighbourhood of Colon. The object of the excursion was to visit the Indian villages and arrange for their administration by the Government of Panama, as some of the Caciques had shown resentment at their transference to that Government from the Government of Colombia. The Island of Perdon, renamed Porvenir, was chosen as the headquarters of the administration of the district. The account of the excursion is accompanied by an excellent album of photographs, and two of these are here reproduced. The album and the account of the expedition (in Spanish) are placed in the collection of the Society.

New Expedition planned by Dr. Hamilton Rice.

Writing from Newport, R.I., on August 16, our medallist Dr. Hamilton Rice outlined his plans for a new expedition to the interior of South America with a view to still further extending our knowledge of the region previously explored by him on the borders of Brazil, Colombia, and Venezuela. This time he proposes to ascend the Amazon and Rio Negro to Santa Isabel, pushing on thence by steam launch to the Guainia. By launch and canoes he hopes to reach the source of this river, which lies between the Papunaua branch of the Inirida and the Isana (see Dr. Rice's map in *Journal*, August 1914). He also proposes to survey and map the Casiquiari (which links the basins of the Orinoco and Amazon), determining the relative size of the two sections of the Upper Orinoco, the currents and depths, etc., besides solving some of the other hydrographical problems of this region, and thus filling in more completely the north-east corner of his map. For the river work he is building in New York a launch 40 feet long, drawing $2\frac{1}{2}$ feet, and with a tank capacity of 700 gallons of petrol. Its speed will be 12 miles per hour. Dr. Rice also has in view the possible determination of longitude by wireless, and hopes to effect barometric determinations of altitude which will form the basis for a more accurate knowledge of the hypsometry of this part of South America than we yet possess. He was planning to leave for Brazil early in October if possible.

POLAR REGIONS.

Rescue of Sir E. Shackleton's Men.

The general satisfaction at the rescue of the twenty-two men left by Sir E. Shackleton on Elephant Island in the South Shetlands is shared in a special degree by geographers, who rejoice that Sir Ernest's determined efforts for their relief have at last been crowned with success. The good news was received on September 4, and the King's congratulations were at once conveyed by telegram to Sir Ernest Shackleton, who also received a cable from Queen Alexandra expressing her satisfaction at his success. After his unsuccessful attempt in the *Emma* (*Journal*, August, p. 175, September, p. 273), Sir Ernest obtained from the Chilean Government the use of the steamer *Yelcho*, Commandante Pardo, which, manned and equipped at the expense of that government, left

CALEDONIA HARBOUR, PANAMA.

ISLA NUSATUPO, PANAMA.

Punta Arenas for the south on August 4. Approaching Elephant Island from the north-west, the *Yelcho* pushed through numerous stranded bergs and reached Wild's camp on August 30. All the party were found alive and well, and were immediately taken on board, the steamer starting homeward within an hour of her arrival. The party had spent over four months in the most trying circumstances, and it is no doubt mainly due to the qualities of their leader, Mr. Frank Wild, that they were able to maintain their courage and health in their precarious position. Mr. Wild's report states that on April 25, the day after Sir Ernest had left for South Georgia, the island was beset with dense pack-ice. The ice-hole in which the men had taken shelter became untenable, and a dwelling had to be made of the two boats, set up as far as practicable from the sea on a narrow spit of land 40 yards wide surrounded by inaccessible cliffs and ice-laden seas. The weather is described as appalling, and the vitality of the men was much lowered by exposure. Severe blizzards raised heavy seas, and the party were in danger of being swept away, their safety being due only to the protection afforded by an ice-foot. The waves raised by the calving of the adjacent glacier were also a source of peril. Owing to the relatively high temperature during the latter part of the stay, the improvised hut was constantly flooded, necessitating much labour in bailing. Apart from the small supply of bovril and other provisions left by Sir E. Shackleton, the party depended for food chiefly on small penguins (which, however, arrived late in the season), seals being unable to land owing to the ice-foot. Latterly seaweed and limpets were obtained, but fishing was impossible. From June onwards they were under a constant pall of fog and snow, though the wind was less violent. The sea opened from time to time and hopes of rescue were raised, but unfortunately the previous attempts had synchronized with times of besetment. The ice had been driven away by a gale only two days before the arrival of the *Yelcho*. During the long detention the spirits of the party were kept up by regular attention to the daily round of duties, by exercise on a track 100 yards in length, by reading aloud from the slender stock of books, and by an occasional concert. Constant watchfulness on the part of the two surgeons, Drs. Macklin and McIlroy, kept the men in fairly good health, though frost-bite rendered necessary the amputation of one man's toes. Hope of succour was never abandoned, but before relief arrived preparations were being made for an attempt to reach Deception Island—a summer rendezvous of whalers—in the remaining small boat. It is to be hoped that equal success will attend the measures for the rescue of the other party of ten men, stranded on the opposite side of the Antarctic region, whose position must meanwhile be the cause of grave anxiety.

GENERAL.

The Late Prof. James Geikie.

A biography of the late Prof. James Geikie is in course of preparation, and it would greatly aid the work if those who have letters or communications of interest from him would send these to Dr. Marion Newbigin, Royal Scottish Geographical Society, Synod Hall, Edinburgh. They would be carefully preserved and returned after being copied.

ISLA NUSATUPO, PANAMA.

CORRESPONDENCE.

A Former Connection Between the Nile and the Chad.

With reference to the observations of Captain Stigand and Mr. Holmes in the *Geogr. Journ.* for August 1916, on the Chad and its connection with the Nile, may I point out that in my paper,* from which Mr. F. R. Cana took his information as to the Wadi El Fardi in his 'Sahara in 1915,' the three names "Wadi el Fardi," "Wadi Tibbu," and "Bahr el Ghazal" are given as being used impartially by the natives for both the Wadi el Fardi and the Chad Bahr el Ghazal. The first name, however, seems to be generally applied to the northern wadi and the last to the southern one.

The similarity in names would seem to show that the two wadis form a continuous watercourse, and supports Mr. Holmes' view that it was by this means that the Nile and the Chad acquired their common fish fauna. As, however, the native who gave me the information described the Bahr el Ghazal as originating from the junction of two streams flowing from the east and west respectively of Jebel Kusu in the Tibesti range, which joined each other on the south of the mountain, it did not occur to me when putting the information together and making the map that the Wadi el Fardi and the Bahr el Ghazal could be the same. But it has struck me since that possibly my Arab informant may have made a common mistake and taken the source of a large tributary of the Bahr el Ghazal for that of the main river; so assuming Captain Vignon's view that the Bahr el Ghazal flows out of and not into the Chad to be correct, it seems very probable that it eventually either joins or becomes the Wadi el Fardi, receiving on its way, as a large tributary, the stream from the Kusu. I was told that fish skeletons were often to be seen in both the Bahr el Ghazal and the Wadi el Fardi.

Captain Stigand suggests that the Victoria Nile formerly followed a more westerly course; if so it seems hardly necessary to assume that it reached so far west as the Wadi el Fardi, as it may have rejoined the present Nile bed by way of the Wadi Howar or perhaps the Wadi Melk. The former was described to me by the native who first told me of it as being in places "as deep and wide as the Nile."

W. J. HARDING KING.

Note.—At the request of the editors of the *Geographical Journal*, Mr. Heawood has written the following note on the historical aspect of the discussion.

It must be remembered that Captain Vignon, though adding much to our topographical knowledge of the Bahr el Ghazel depression, was not provided with the means of determining altitudes with accuracy, and himself allows that precise instrumental observation is needed to clear up the problem of this wadi. The idea that it represents a former *effluent* of Lake Chad is not of course new, but was already held by Nachtigal so far back as 1871 (see especially his 'Sahara und Sudan,' Vol. 2, Book 4, Chapter 5). Even Barth, twenty years earlier, was positively assured that it was an effluent, though he discredited the story. Some recent French explorers, too, have believed the slope to be *towards* the lake. One would like to feel assured that the name Bahr-el-Ghazal is really used in reference to a wadi *north* of the Tibesti highlands, for in his map accompanying the paper of 1913 Mr. Harding King applied it only to

* "The Libyan Desert from Native Information," by W. J. Harding King, *Geogr. Journ.*, September 1913.

the southern wadi, which he showed as running in the opposite direction to that of the Wadi el Fardi. Even the use of the same name would be far from proving the identity of the two wadis, uneducated travellers being prone enough to form hasty conclusions as to the identity of various streams crossed by them. (Those acquainted with the narrative of the mediæval traveller John de Marignolli will remember that he regarded practically all the streams crossed by him between Russia and China as forming the course of one great river.) In the case of the dry channels of a desert region, the temptation is unusually great, and the problem is here complicated even for scientific observers by the possibility that the original consistent slope due to fluviatile erosion has been disturbed by tectonic movements, or by desert forms of erosion and deposition (cf. M. Chudeau's paper on the hydrography of the Timbuktu region noticed in the Monthly Record for the present month).

E. H.

Notes on the Geography of Imbros.

The excellence of Mr. Ogilvie's notes on the climate and geology of the island of Imbros in the August number of this *Journal* makes one unwilling to criticize the latter part of his paper. But the Wagtail which he saw so commonly on Imbros and Gallipoli last autumn was *Motacilla alba*, the White Wagtail, and not *M. lugubris*, the Pied. The Pied is a British species or subspecies, which only occurs in the extreme west of the continent. The Red-legged Partridge is similarly not found in Eastern Europe. *Caccabis chukar* and *C. saxatilis* both occur round the Ægean, but I did not see any specimens in the hand, and cannot tell which it was on Imbros. A full account of birds seen during the campaign has been published in the April *Zoologist* by Captain A. W. Boyd. Of the insects, as Mr. Ogilvie truly says, "there were many to which one could not put a name." Some account of the Lepidoptera will shortly appear in the *Entomologist's Record*. As to the inhabitants, I did not notice the seclusion of women; at any rate, up in the hills, the women were very ready to show one hospitality, bringing one all kinds of fruit and milk and biscuits and bunches of marigolds and scented herbs, and keeping up a loud and uninterrupted flow of conversation, to which, I must confess, I was not very responsive.

D. A. J. Buxton.

GEOGRAPHICAL LITERATURE: ADDITIONS TO THE LIBRARY. Edward Heawood, Librarian, R.G.S.

For list of abbreviations see January number.

EUROPE.

Albania—Travel. **Baldacci.**

B.R.S.G. (*Rome*), Serie V., 5 (1916): 164–200, 323–336, 368–384.

Nell' Epiro Turco e Greco. Itinerari Albanesi del 1895. By A. Baldacci.

Alps—Lakes. *Z. Gletscherkunde* 9 (1914): 1–41. **Lautensach.**

Die kleinen Seebecken der Tessiner Alpen. Von Hermann Lautensach. *Illustrations.*

Balkan Peninsula—Political. **Cvijić.**

Questions Balkaniques. Par Jovan Cvijić. I. Une publication anglaise sur les problèmes Balkaniques. Les assertions d'un écrivain Bulgare. Les bases

géographiques de la question Macédonienne. Remarques sur l'ethnographie de la Macédoine. Paris and Neuchatel: Attinger Frères, [1916]. Size 9 × 6, pp. 79.

The English publication is Miss Newbigin's book, which the writer highly commends.

Balkans. **Leger.**

Louis Leger. Serbes, Croates et Bulgares. Études historiques, politiques et littéraires. Paris: G. Maisonneuve et Fils, 1913. Size 10 × 6½, pp. vi. and 222. *Presented.*

Bulgaria. **Andreas.**

With Gypsies in Bulgaria. By Andreas (Mui Shuko). Liverpool: Young & Sons, 1916. Size 8 × 5, pp. 142. *Map and Illustrations. Price 2s. 6d. net. Presented.*

See review in the present number.

Danube—Economic. *G.Z.* **22** (1916): 233–249. **Günther.**

Die Donau in verkehrsgeographischer und weltwirtschaftlicher Bedeutung. Von S. Günther.

Danube—Economic. *Z. Ges. E. Berlin* (1916): 265–303. **Heiderich.**

Die Donau als Verkehrsstrasse. Von Franz Heiderich.

Europe—Slavs. **Bailey.**

The Slavs of the War Zone. By the Rt. Hon. W. F. Bailey. London: Chapman & Hall, 1916. Size 9 × 5½, pp. xii. and 266. *Map and Illustrations. Price 10s. 6d. net. Presented.*

France—Marseilles. *B.R.S.G. Italiana*, Ser. V. 5 (1916): 547–574. **Gribaudi.**

Il porto di Marsiglia e il canale Marsiglia-Rodano. By Piero Gribaudi. *Sketch-maps.*

Traces the fortunes of Marseilles as a port in the face of the competition of Genoa.

France and Germany—Alsace-Lorraine. **Vidal de la Blache.**
Ann. G. **25** (1916): 161–180.

Evolution de la population en Alsace-Lorraine et dans les départements limitrophes (second article). Par P. Vidal de la Blache.

Holland—Historical. **Blok and Beekman.**

Geschiedkundige Atlas van Nederland. De Bourgondische Tijd. Eerste Aflevering. De Noordelijke Nederlanden in 1476. Door Dr. P. J. Blok.—Het Bourgondische Rijk in 1476. Door Dr. P. J. Blok.—De St. Elizabethsvloed, 1424. Door Dr. A. A. Beekman. The Hague: M. Nijhoff, 1915. Size 10 × 6½, pp. 94.

Holland—Historical. **Overvoorde.**

Geschiedkundige Atlas van Nederland. De rechterlijke indeeling na 1795. Door Dr. J. C. Overvoorde. The Hague: M. Nijhoff, 1915. Size 10 × 6½, pp. 32.

Levant—Geophysics. *Ann. Idrografici* **9** (1915): 193–287. **Carnera.**

Determinazioni di gravità relativa in Atene ed in alcune isole del Mar Egeo. By L. Carnera.

Mediterranean—Meteorology. *Ann. Idrografici* **9** (1915): 77–124. **Marini.**

Carte di pressione e di venti per il bacino Mediterraneo. By L. Marini. *Charts.*

North Sea—Ports. *G.Z.* **22** (1916): 28–56; 91–106. **Oppel.**

Die festländischen Seehandelsstädte an der Nordsee. Von A. Oppel.

North-Western Europe—Historical. **Beltrán y Rózpide.**
B.R.S.G. (Madrid), Riv. G. Col. y Merc. **13** (1916): 129–132.

La Geografia del Noroeste de Europa según Cervantes. By Ricardo Beltrán y Rózpide.

Poland—Political. *Petermanns M.* **62** (1916): 8–9. **Kurth.**

Der preussische Besitz auf polnischen Boden bis zum Frieden von Tilsit. Von Otto Kurth. *Map.*

Poland—Sochaczew. *Z.G.E. Berlin* (1915): 624–633. **Brandt.**

Der Burgberg von Sochaczew. Von Bernhard Brandt. *Illustrations.*

Portugal—Climate. **Dalgado.**

The climate of Portugal and notes on its health resorts. By Dr. D. G. Dalgado. Part I. The climate of Portugal. Lisbon, 1913. Size 8½ × 6, pp. xii. and 480. *Maps. Presented.*

Russia—Economic. *G. Rev.* 1 (1916): 249–265. **Reynolds.**
The economic resources of the Russian Empire. By E. K. Reynolds. *Map and Illustrations.*

Spain—Study of Geography. *B.R.S.G.* (*Madrid*) 58 (1916): 143–163. **Buen.**
La ciencia geográfica en España. By Odón de Buen.

Sweden—Economic. *Scottish G. Mag.* 32 (1916): 227–241. **Birrell.**
Notes on Sweden, with special reference to the forests in relation to industry and commerce. By J. H. Birrell. *Sketch-map.*

Switzerland—Appenzell. **Ott.**
XIV. u. XV. Jb. G.-Ethnogr. Ges. Zürich, 1913–14 *und* 1914–15 (1915): 33–160.
Die Siedelungsverhältnisse beider Appenzell. Von Adolf Ott. *Map and Illustrations.*

Switzerland—Guides. **Füssli.**
Orell Füssli's Wanderbilder. No. 114–116. Lugano und Umgebung. Von J. Hardmeyer. Neu bearbeitet von Dr. Ed. Platzhoff-Lejeune. 5. Auflage (pp. 126). No. 318–320. Bilder vom Vierwaldstätter-See. Von Alfred Ryffel mit einem Begleitwort v. Isabelle Kaiser (pp. 12). No. 324–325. Die Arth-Rigi-Bahn. Dritte neu bearbeitete Auflage von Dr. Alfred Schaer (pp. 38). No. 339–340. Der Uetliberg und die Albiskette. Von Gottlieb Binder (pp. 66). Zurich: Orell Füssli, N.D. Size 7½ × 5. *Maps and Illustrations. Presented.*

Turkey—Macedonia. *G.Z.* 22 (1916): 126–139. **Krebs.**
Der mazedonische Kriegsschauplatz. Von Norbert Krebs.

Turkey—Macedonia. *Z. Ges. E. Berlin* (1916): 129–157. **Oestreich.**
Mazedonien. Von Karl Oestreich.

United Kingdom—Forestry. *J.R.S. Arts* 64 (1916): 350–360. **Stebbing.**
Forestry and the war. By Edward Percy Stebbing.

United Kingdom—Inland cruises. **Bonthron.**
My holidays on inland waterways. 2000 miles cruising by motor-boat and pleasure skiff on the canals and rivers of Great Britain. By P. Bonthron. London: T. Murby & Co., [1916]. Size 8½ × 5½, pp. xviii. and 186. *Map and Illustrations. Price 4s. 6d. net. Presented.*

United Kingdom—Phenology. *Petermanns M.* 62 (1916): 81–85. **Ihne.**
Phænologische Karte des Frühlingseinzuges auf den Britischen Inseln. Von E. Ihne. *Maps.*
Dr. Ihne, who has long been known for his phenological work in Germany, here extends his survey to the British Islands.

United Kingdom—Rainfall. *Q.J.R. Meteor. S.* 42 (1916): 13–21. **Comissopulos.**
On the seasonal variability of rainfall over the British Isles. By N. A. Comissopulos. *Map.*

United Kingdom—Road-books. **Fordham.**
Road-books and Itineraries bibliographically considered. [With a catalogue of the Road-books and Itineraries of Great Britain and Ireland to the year 1850.] A paper read before the Bibliographical Society, 17 November 1913. By Sir Herbert George Fordham. London, 1916. Size 9 × 7, pp. 45. *Presented.*

United Kingdom—Scotland. *Scottish G. Mag.* 32 (1916): 209–216. **Rhodes.**
Notes on the former courses of the river Devon. A suggested evolution for part of the river system of Fife and Kinross. By J. E. Wynfield Rhodes. *Sketch-map and Illustrations.*
See Monthly Record, September.

United Kingdom—Scotland—Geology. **Gregory.**
Scottish G. Mag. 32 (1916): 279–282.
The Auld Wives' Lifts—a pseudo-megalithic tor. By J. W. Gregory. *Illustrations.*
Three huge stones in the form of an arch, wrongly supposed to be a cromlech.

United Kingdom—Sunshine. *Q.J.R. Meteor. S.* 42 (1916): 23–43. **Brodie.**
The incidence of bright sunshine over the United Kingdom during the thirty years 1881–1910. By Fredk. J. Brodie. *Maps.*
See note in the July number, p. 79.

United Kingdom—Transport. **Jackman.**

The development of transportation in modern England. By W. T. Jackson. 2 vols. Cambridge: University Press, 1916. Size 9½ × 6½, pp. xvi. and 820. *Facsimile and Sketch-maps. Price 24s. net. Presented.*

ASIA.

Armenia—Historical. **Williams.**

Armenia: past and present. A study and a forecast. By W. Llewellyn Williams, with an introduction by T. P. O'Connor. London: P. S. King & Son, 1916. Size 7½ × 5, pp. xii. and 214. *Maps. Price 3s. 6d. Presented.*

See review in the present number.

Central Asia—Altai. **Obrucheff.**

Altaian Studies. By V. A. Obrucheff. (From *Zemlevyedeniye*, 1915, Part 3.) Moscow, 1915. Size 10 × 6½, pp. 71. *Maps and Illustrations.*

China—Pekin. **Millot.**

Pékin et ses palais en avril 1901. Par Stanislas Millot. (Extrait du B. Ass. Amicale Franco-Chinoise d'Oct. 1915.) Paris: G. Leroux, 1916. Size 9½ × 6, pp. 45. *Illustrations.*

India—Historical. **Watters.**

On Yuan Chwang's travels in India, 629–645 A.D. By Thomas Watters. Edited, after his death, by T. W. Rhys Davids and S. W. Bushell. 2 vols. (Oriental Translation Fund, New Series, vols. 14 and 15.) London: Royal Asiatic Society, 1904–05. Size 8½ × 5½, pp. (vol. 1) xiv. and 402; (vol. 2) 358. *Maps. Presented.*

Japan. **Longford.**

Japan of the Japanese. By Joseph H. Longford. 2nd edit. London: Sir I. Pitman, 1915. Size 7½ × 5½, pp. xvi. and 320. *Map and Illustrations. Price 6s. net.*

Japan—Eruption. *G. Rev.* (*Amer. G.S.*) 1 (1916): 359–362. **Powers.**

The eruption of Yake-Dake, Japan, in 1915. By Sidney Powers. *Illustrations and Map.*

Japan—Meteorology. **Terada, Yokota, and Otuki.**

J. College Sc., Imp. Univ. Tokyo 37 (1916): Art. 4, pp. 32.

On the distribution of cyclonic precipitation in Japan. By Torahiko Terada, Takezô Yokota, and Syôhu Otuki. *Maps.*

Japan—Seismology. **Omori.**

B. Imp. Earthquake Investn. Committee 8 (1916): 35–179.

The Sakura-jima eruptions and earthquakes. II. By F. Omori. *Maps and Illustrations.*

Sketches the history of Sakura-jima eruptions, and discusses the propagation of sound waves, the accumulation and transport of ashes, changes of level of sea and land, and horizontal displacements during that of 1914.

Malay Archipelago—Java—Meteorology. **Bemmelen.**

Results of Rainfall Observations in Java. By Dr. Van Bemmelen. (Published by Order of the Government of Netherlands India.) Batavia, 1914. Size 14 × 10, pp. xxiv. and 174. Atlas separate. Size 24 × 15½. [In Dutch and English.] *Presented.*

Philippines—Salt. **Cox and Dar Juan.**

Philippine J. Sc. 10 (1915), Sec. A.: 375–403.

Salt industry and resources of the Philippine Islands. By Alvin J. Cox and T. Dar Juan. *Illustrations.*

Russia—Siberia—Kamchatka. **Reinhard.**

Z. Ges. F. Berlin (1915): 180–183.

Ueber die eiszeitliche Vergletscherung Kamtschatkas. Von A. v. Reinhard.

Russian Central Asia. *Z. Ges. E. Berlin* 1915 (1915): 155–170. **Machatschek.**

Aus Russisch-Turkestan. Eine geographische Skizze. Von Fritz Machatschek.

Siam—Navigation, etc. **Ministry of Lands.**

Kingdom of Siam. Ministry of Lands and Agriculture. Royal Irrigation Department. Project estimate for works of irrigation, drainage, and navigation to develop the plain of Central Siam. Vols. 1 to 4. Also a copy of the minute by H.R.H. Prince Luang Rajaburi Direkriddhi. Report by T. R. J. Ward. Bangkok, 1915.

Size 13 × 8, pp. (vol. 1) 136; (vol. 2) 144; (vol. 3) 116. (iv.) *Maps.* Report, pp. 28. *Presented.*

Tibet—Lhasa. *National G. Mag.* **29** (1916): 273–295. **White.**
The world's strangest capital. By John Claude White. *Illustrations.*

Turkey. **Hubbard.**
From the Gulf to Ararat. An expedition through Mesopotamia and Kurdistan. By G. E. Hubbard. Edinburgh and London: Wm. Blackwood & Sons, 1916. Size 8½ × 5½, pp. xvi. and 274. *Illustrations. Price* 10*s.* 6*d. net. Presented.*
See review in the September number, p. 265.

Turkey—Asia Minor. *Blackwood's Mag.* **199** (1916): 684–689. **W. J. C.**
Westward of Erzeroum. By W. J. C.

Turkey—Syria—Historical. **Bouchier.**
Syria as a Roman Province. By E. S. Bouchier. Oxford: B. H. Blackwell, 1916. Size 7½ × 5, pp. vi. and 304. *Sketch-map and Illustration. Price* 6*s. net.*

AFRICA.

Cape Colony—Phytogeography. **Marloth.**
South African J. Sc. **12** (1916): 383–390.
The effects of droughts and of some other causes on the distribution of plants in the Cape region. By R. Marloth.

East Africa—Frontier. *Ann. G.* **25** (1916): 206–218. **Alluaud.**
La frontière anglo-allemande dans l'Afrique orientale. By Charles Alluaud. *Sketch-map and Illustrations.*

East Africa—Kilimanjaro. *Z. Gletscherkunde* **9** (1916): 289–305. **Klute.**
Beobachtungen über Zackenfirn (Büsserschnee) und dessen Entstehung am Kilimandscharo. Von F. Klute. *Illustrations.*

Egypt—Language. **Willmore.**
The spoken Arabic of Egypt. Grammar, exercises, vocabularies. By J. Selden Willmore. 2nd revised and enlarged edition. London: D. Nutt, 1905. Size 8 × 5½, pp. xxviii. and 454. *Price* 10*s.* 6*d. net.*

Egypt and Sudan—Guide. **Macmillan.**
Guide to Egypt and the Sûdân, including a description of the route through Uganda to Mombasa. 7th edit. London: Macmillan & Co., 1916. Size 7 × 4½, pp. xx. and 196. *Maps and Plans. Price* 7*s.* 6*d. net. Presented.*

Egypt and Sudan—Magnetism. **Hurst.**
Ministry of Finance, Egypt. Survey Department. The Magnetic Survey of Egypt and the Sudan. By H. E. Hurst. Surv. Dept. Paper No. 33. Cairo, 1915. Size 11 × 7, pp. 53. *Maps.*

French Sahara. *La G., B.S.G. Paris* **30** (1915): 417–436. **Chudeau.**
L'Azaouad et le Djouf. By R. Chudeau. *Map and Illustrations.*

French Sudan—Hypsometry. *Ann. G.* **25** (1916): 190–205. **Chudeau.**
Recherches hypsométriques dans le bassin de Tombouctou. By R. Chudeau. *Sketch-map.*
Noticed in the Monthly Record, *supra*, p. 352.

Morocco—Geomorphology. *C.R.A. Sc. (Paris)* **162** (1916): 329–332. **Gentil.**
Sur la structure du Moyen Atlas (Maroc central). By Louis Gentil.

South Africa—Namaqualand. **Rogers.**
T. Geol. S. South Africa **18** (1916): 72–101.
The geology of part of Namaqualand. By A. W. Rogers. *Illustrations and Map.*

Suez Canal—Economic. *G.Z.* **22** (1916): 87–91. **Dix.**
Die verkehrspolitische Bedeutung des Suezkanals. Von Arthur Dix.

NORTH AMERICA.

Alaska—Railway. *National G. Mag.* **28** (1915): 567–589. ——
Alaska's new railway. *Illustrations.*

Canada. **Dept. of Trade and Commerce.**

Canada. The country of the Twentieth Century. By Watson Griffin. Ottawa: Department of Trade and Commerce, 1915. Size 10 × 6½, pp. 284. *Maps and Illustrations. Presented.*

Canada—Altitudes. **White.**

Commission of Conservation, Canada. Dictionary of altitudes in the Dominion of Canada (Second Edition). By James White. Ottawa, 1916. Size 10 × 7, pp. xii., 251.

A companion volume to 'Altitudes in Canada,' the arrangement being throughout alphabetical under the main heads of provinces and territories. The localities are defined by counties where such exist, otherwise by latitude and longitude.

Canada—Altitudes. **White and Ferguson.**

Commission of Conservation, Canada. Altitudes in the Dominion of Canada (Second Edition). By James White, assisted by George H. Ferguson. Ottawa, 1915. Size 10 × 7, pp. xxiii., 603. *Maps.*

Embodies the results of many levelling operations carried out since the first edition of this indispensable work of reference appeared. The data are grouped firstly by the lines of railway, secondly by provinces and their counties, and lastly by the system of the St. Lawrence and its lakes.

Canada—British Columbia—Texada Island. **McConnell.**

Canada, Geol. Surv., Mem. 58 (1914): pp. v., 112.

Texada Island, B.C. By R. G. McConnell. *Maps and Illustrations.*

Canada—Coal. **Dick.**

Commission of Conservation, Canada. Conservation of coal in Canada. With notes on the principal coal-mines. By W. J. Dick. Toronto, 1914. Size 10 × 7, pp. xii., 212. *Maps and Illustrations.*

After a general discussion of the problem, the several Canadian colliery districts are dealt with in turn. Maps indicate the areas in which coal from various sources of supply is used in Canada, both for domestic purposes and on the railways. They show that while Canadian coal is the basis of supply in the east and west, the whole centre depends in the main on the United States.

Canada—Early Travel. **Tyrrell.**

David Thompson's narrative of his explorations in Western America, 1784–1812. Edited by J. B. Tyrrell. (Publ. Champlain Soc., vol. 12.) Toronto, 1916. Size 10 × 6½, pp. xcviii. and 582. *Maps and Illustrations.*

Canada—Resources. **Victor.**

Canada's future. What she offers after the war. A symposium of official opinion. Edited by E. A. Victor. Toronto: Macmillan Co., 1916. Size 9½ × 6, pp. xvi. and 320. *Portrait. Presented.*

Newfoundland—Forests. *J.R.S. Arts* 64 (1916): 439–452. **Morris.**

The forest resources of Newfoundland. By Sir Daniel Morris.

United States—California—Lassen Peak. **Diller.**

Science, N.S. 43 (1916): 727–733.

The volcanic history of Lassen Peak. By J. S. Diller. *Sketch-maps.*

See note in the August number.

United States—Climatology. *G. Rev.* 1 (1916): 203–208. **Jefferson.**

Aridity and humidity maps of the United States. By Mark Jefferson. *Maps.*

United States—Coast and Geodetic Survey. **Bowie.**

Science, N.S. 43 (1916): 655-656.

The One Hundredth Anniversary of the United States Coast and Geodetic Survey. By William Bowie.

United States—Geodesy. **Ross.**

Department of Commerce. U.S. Coast and Geodetic Survey. Geodesy. Latitude observations with photographic zenith tube at Gaithersburg Md. By Frank E. Ross Special Publication No. 27. Washington, 1916. Size 11½ × 9, pp. 127 *Illustrations.*

United States—Florida—Phosphates. **Matson.**

U.S. Geol. Surv. B. 604 (1915): pp. 101.

The phosphate deposits of Florida. By George Charlton Matson. *Maps and Illustrations.*

United States—Meteorology. **Alexander.**
Monthly Weather Rev. 43 (1915): 322-340.
Distribution of thunderstorms in the United States. By W. H. Alexander.

United States—Minnesota. *J.G.* 14 (1916): 161–165. **Johnston.**
The physical geography of Minnesota. By A. Walfred Johnston.
The whole number is concerned with Minnesota under various aspects.

United States—Minnesota. *J.G.* 14 (1916): 168–174. **Van Cleef.**
The climate of Minnesota. By Eugene van Cleef. *Maps.*

United States—Mississippi. **Schoff.**
The Mississippi River improvement. A brief description, with illustrations, by Wilfred H. Schoff. (Reprinted from *Commercial America*, October, November, December, 1915.) Philadelphia, 1915. Size 9 × 6, pp. 44. *Illustrations.*

CENTRAL AND SOUTH AMERICA.

Argentine—Guide. **Martinez.**
Baedeker of the Argentine Republic. By Albert B. Martinez. Including also parts of Brazil, the Republic of Uruguay, Chile, and Bolivia. 4th edit. New York and London: Appleton & Comp., 1916. Size 7 × 5, pp. xviii. and 480. *Maps, Plans, and Illustrations. Price* 15*s.*

Brazil—Expedition. *G. Rev.* 1 (1916): 161–191. **Miller.**
The descent of the Rio Gy-Paraná. By Leo E. Miller. *Illustrations and Map.*
Describes the work of one of the three parties of the Roosevelt-Rondon Expedition.

Brazil—Bahia—Economic. *Pan-American Mag.* 23 (1916): 11–61. ——
Special articles on the State of Bahia. *Sketch-map and Illustrations.*

AUSTRALIA AND PACIFIC ISLANDS.

Hawaii—Mauna Loa. *American J. Sc.* 41 (1916): 383–408. **Wood.**
Effects in Mokuaweoweo of the eruption of 1914. By H. O. Wood. *Maps and Illustrations.*

New Caledonia—Ethnology. *Man* 16 (1916): 113–115. **Brown.**
Notes on a visit to New Caledonia. By J. Macmillan Brown. *Illustrations.*

New Guinea—British—Ethnology. **Malinowski.**
T. and P.R.S. South Australia 39 (1915): 494–707.
The natives of Mailu: preliminary results of the Robert Mond research work in British New Guinea. By B. Malinowski. *Illustrations.*

New Zealand—Geology. *Geol. Mag.*, Dec. vi., 3 (1916): 243–249, 314–320. **Cotton.**
The structure and later geological history of New Zealand. By C. A. Cotton. *Illustration and Map.*

New Zealand—Southern Alps. **Moreland.**
Through South Westland. A journey to the Haast and Mount Aspiring, New Zealand. By A. Maud Moreland. 2nd edit. London: Whitcombe & Tombs, [1916]. Size 8½ × 5½, pp. xviii. and 220. *Map and Illustrations. Price* 6*s. net. Presented.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Geophysics. *K.A. Wetens. Amsterdam, P. sect. Sc.* 17 (1915): 1295–1308. **Sitter.**
On isostasy, the moments of inertia, and the compression of the Earth. By W. de Sitter.

Limnology—Temperature. **Halbfass.**
Naturwissens. Wochenschrift, N.F. 14 (1915): 561–566.
Aufspeicherung und Abgabe von Wärme in Binnenseen. Von W. Halbfass.
Suggested by the work of Prof. Birge on the Finger Lakes of New York (cf. *Journal*, vol. 46, pp. 155, 318).

Meteorology. **Hildebrandsson.**
K. Svenska Vetenskapsakad. Handlingar 51 (1914): No. 8, pp. 16.
Quelques recherches sur les centres d'action de l'atmosphère. Par H. Hildebrand Hildebrandsson. V. (Fin). *Maps and Illustrations.*

Oceanography—Atlantic. **Galbé.**

K.A. Wetens. Amsterdam, P. sect. Sc. **17** (1915) : 1147–1158.

On the relation between departures from the normal in the strength of the trade-winds of the Atlantic Ocean and those in the water-level and temperature in the northern European seas. By P. H. Gallé. *Illustrations.*

Seismology. *G. Ts.* **23** (1916) : 189–197. **Harboe.**

Oberstløjtnant Jordklodens undersøgelse med sejsmograf. Af E. G. Harboe.

Zoogeography—Bird migration. **Wesemüller.**

Naturwissens. Wochenschrift, N.F. **14** (1915) : 513–519 ; 529–535.

Die deutschen Storchmarkierungen. Von A. Wesemüller. *Maps.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropology. **Osborn.**

Men of the Old Stone Age. Their environment, life, and art. By Henry Fairfield Osborn. London : G. Bell & Sons, 1916. *Maps, Diagrams, and Illustrations. Price* 21*s. net. Presented.*

See review in the present number.

Ethnology—Gypsy Migrations. *Ymer* (1916) : 45–60. **Numelin.**

Zigenarvandringarna. Av Ragnar Numelin.

Ethnology—Turkey. *G.Z.* **22** (1916) : 65–87. **Oberhummer.**

Die Türken und das osmanische Reich. Von Eugen Oberhummer. *Illustrations.*

See note in the June number, p. 479.

History of Geography. *La G.* (*Novara*) 4 (1916) : 62–73. **Vernero.**

I concetti cosmografici e le cognizioni geografiche dell' Ariosto in rapporto a quelle del suo tempo. By Mich le Vernero. *Facsimile map.*

History of Navigation. **Lubbock.**

The China Clippers. By Basil Lubbock. 3rd edit. Glasgow : J. Brown & Son, 1916. Size 8½ × 5½, pp. xii., 388, and xxxiv. *Illustrations. Price* 6*s. net. Presented.*

First published in 1914. The popular author of sea-stories has brought together in handy form a large amount of information on a type of vessel as remarkable as ever sailed the seas, whose feats are here recorded for the benefit of all interested in the history of shipping. The material has been gathered from countless logs and from information supplied by those who owned, designed, or sailed the ships.

BIOGRAPHY.

Pinzon. **McClymont.**

Vicente Añes Pinçon. By James Roxburgh McClymont. London : B. Quaritch, 1916. Size 9 × 7½, pp. 82. *Price* 10*s.* 6*d. net. Presented.*

GENERAL.

British Empire. **Paladini.**

Carlo Paladini. Impero e Libertà nelle Colonie Inglesi. Prefazione di Sir Harry Johnston. Florence : R. Bemporad & Figlio, 1916. Size 9 × 6, pp. xviii. and 510. *Maps. Price* 9*s.* 6*d. Presented.*

British Empire—Text-book. **Bunting and Collen.**

A geography of the British Empire. By W. L. Bunting and H. L. Collen. Cambridge : University Press, 1916. Size 10 × 7½, pp. 166. *Sketch-maps, Diagrams, and Illustrations. Price* 4*s. Presented.*

Camping Hints. **Miller.**

Camp craft. Modern practice and equipment. By Warren H. Miller. With introduction by Ernest Thompson Seton. London : B. T. Batsford, [1915]. Size 8 × 5½, pp. xiv. and 282. *Illustrations. Price* 7*s.* 6*d. net.*

Statesman's Year-book. **Keltie and Epstein.**

The Statesman's Year-Book : statistical and historical annual of the States of the World for the year 1916. Edited by Dr. J. Scott Keltie and Dr. M. Epstein. London : Macmillan & Co., [1916]. Size 7½ × 5, pp. xliv. and 1560. *Maps. Price* 10*s.* 6*d. net. Presented.*

NEW MAPS AND PHOTOGRAPHS: ADDITIONS TO THE MAP ROOM.

E. A. Reeves, Map Curator, R.G.S.

EUROPE.

Europe. **E. Stanford, Ltd.**

Stanford's Reproduction of part of the German Official Map of Central Europe (1 : 300,000). Enlarged to the scale of 4 miles to 1 inch (1 : 253,440). Sheet : Luck. Size 18 by 23 inches. London : E. Stanford, Ltd., [1916]. *Price 3s. per sheet. Presented by the Publishers.*

A photographic enlargement of a sheet of the 1 : 300,000 German Government map of Central Europe. Sixteen others of the same series have been already published, and together they cover practically the whole eastern theatre of war. The green tinting of forest is omitted, and the roads are in black only. The names and physical features are not very clear, but this is the fault of the original and not of the enlargement.

Europe. **E. Stanford, Ltd.**

The Russian Battle Front in Europe. Stanford's War Maps No. 19. Scale 1 : 2,217,600 or 1 inch to 35 stat. miles. London : Edward Stanford, Ltd., 1916. *Price 2s. 6d. Presented by the Publishers.*

France. **E. Stanford, Ltd.**

Stanford's Half-inch Map of the Battle Front between the Somme and Soissons. Stanford's War Maps No. 18. Scale 1 : 126,720 or 1 inch to 2 stat. miles. Size 19 by 24 inches. London : Edward Stanford, Ltd., 1916. *Price 2s. 6d. Presented by the Publishers.*

Greece. **Frater.**

Carte de la Région de Salonique par le Colonel Frater. 1st edit. (1916). Scale 1 : 800,000 or 1 inch to 12·6 stat. miles. Size 13 by 16 inches. Paris : Librairie Militaire Chapelot, 1916.

Another of Colonel Frater's useful maps showing the theatre of war. It includes the immediate neighbourhood of Salonika, and extends as far north as Philippopolis, and west to Monastir. Special attention has been given to showing means of communication, and relief is indicated by brown shading. Wooded land is coloured green.

Norway. **Norges Geografiske Opmaaling.**

Topografisk Kart over Kongeriket Norge. Scale 1 : 100,000 or 1 inch to 1·6 stat. miles. Sheet L 14, Junkerdaen. Size 15 by 17 inches. Christiania : Norges Geografiska Opmaaling, 1916.

Spain. **Depósito de la Guerra, Madrid.**

Mapa Militar Itinerario de España. Formado por le Cuerpo de Estado Mayor del Ejercito en 1912. Escale de 1 : 200,000 (1 inch to 3·2 stat. miles). Sheets 4 and 14. Size 18 by 25 inches. Madrid : Depósito de la Guerra.

Sheet 14 comes to the south of sheet 4, and together they include the district from the northern coast to the east of Gijón as far south as León.

ASIA.

Persia and Afghanistan. **Geographical Section, General Staff.**

Persia and Afghanistan. Scale 1 : 4,055,040 or 1 inch to 64 stat. miles. Geographical Section, General Staff, War Office, April 1912. Additions, July 1916. *Price 2s. 6d. net. Presented by the Director of Military Intelligence.* London Agents : E. Stanford, Ltd. ; Sifton, Praed & Co. ; T. Fisher Unwin.

AFRICA.

Africa. **"South Africa."**

Map of Central and South Africa. Scale 1 : 4,750,000 or 1 inch to 75 stat. miles. Size 37 by 28 inches. Supplement to *South Africa*, 25 March 1916. Published by Authority of *South Africa*. London, 1916.

A somewhat roughly executed map without hill-shading. The area included is practically the whole of the continent south of the equator. Territorial divisions are coloured, and amongst the British possessions are shown all the regions that were formerly German. Railways in operation, under construction, and proposed are boldly indicated.

Anglo-Egyptian Sudan. **Survey Office, Khartoum.**

Africa. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. Sheets: 65–I, Hofrat el Nahas; 65–J, Kabaluzu; 65–K, Achwang; 65–M, Said Buldas; 65–P Mesbra el Rek; 77–B, Deim Zubeir; 77–C, Wau; 77–D, Tonj; 77–F, Mount Makamba. Size 18 by 27 inches. Compiled and zincographed at the Survey Office, Khartoum, 1916. *Price* 10 *P.T. each sheet. Presented by the Director of Surveys, Sudan Government, Khartoum.*

Egypt. **Survey of Egypt.**

Topographical Map of Egypt. Scale 1 : 50,000 or 1·3 inch to 1 stat. mile. Sheets: I.–II. N.E., Cairo East; II.–I. N.E., Tûkh; III.–I. N.E. Benha; III.–II. N.E. Minyet El-Qamh; IV.–I. N.W., Tanta; IV.–II. N.W., Kom Hamâda. Size 18 by 19 inches. Giza: Survey of Egypt, 1914–15. *Presented by the Director-General, Survey of Egypt.*

German East Africa. **Geographical Section, General Staff.**

General Map of German East Africa. Scale 1 : 2,000,000 or 1 inch to 31·56 stat. miles. Size 27 by 27 inches. Geographical Section, General Staff, War Office, 1916. *Price* 2*s. net. Presented by the Director of Military Intelligence.* London Agents: E. Stanford, Ltd.; Sifton, Praed & Co.; T. Fisher Unwin.

AMERICA.

Canada. **Dept. of Mines, Ottawa.**

Geological Survey of Canada. Maps: 59A, Wheaton, Yukon Territory, scale 1 : 62,500 or 1·01 inch to 1 stat. mile, size 17 by 19 inches; 150A Halifax and Hants Counties, N.E., scale 1 : 63,360 or 1 inch to 1 stat. mile, size 12 by 18 inches; 160A, Nanaimo, Vancouver Island, B.C., scale 1 : 62,500 or 1·01 inch to 1 stat. mile, size 18 by 12 inches; 169A, Lines of Transportation in Southern Ontario, scale 1 : 2,217,600 or 1 inch to 35 stat. miles, size 11 by 16 inches; 170A, Trap Deposits on the North Shore of Lake Huron, Ontario, scale 1 : 253,440 or 1 inch to 4 stat. miles, size 11 by 28 inches; 171A, Road Metal Deposits in Essex County, Ontario, scale 1 : 253,440 or 1 inch to 4 stat. miles, size 8 by 10 inches; 172A, Road Metal Deposits in Kent County, Ontario, scale 1 : 253,440 or 1 inch to 4 stat. miles, size 11 by 11 inches; 173A, Sand and Gravel Deposits along the north shore of Lake Ontario, Ontario, scale 1 : 253,440 or 1 inch to 4 stat. miles, size 8 by 26 inches. Ottawa: Department of Mines, Geological Survey, 1916. *Presented by the Department of Mines, Geological Survey, Ottawa.*

Canada. **Dept. of the Interior, Ottawa.**

Southern Alberta. Scale 1 : 792,000 or 1 inch to 12·5 stat. miles. Size 38 by 34 inches. Manitoba. Scale 1 : 792,000 or 1 inch to 12·5 stat. miles. Size 37 by 29 inches. Saskatchewan. Scale 1 : 792,000 or 1 inch to 12·5 stat. miles. Size 37 by 32 inches. Maps showing disposition of lands. Prepared in the Railway Lands Branch under the direction of F. C. C. Lynch, Superintendent. Corrected to 1 January 1916. Ottawa: Department of the Interior, 1916. *Presented by the Department of the Interior, Ottawa.*

These three maps are new editions corrected up to 1 January 1916. They show by different colours and symbols (1) Lands finally disposed of (including school lands); (2) lands entered for, sold, or reserved previous to 1915 (unpatented); (3) lands entered for, sold, or reserved during 1915 (unpatented); (4) forest reserves; (6) Dominion parks; (7) timber berths; (8) grazing leases; (9) boundaries of Dominion Lands Agencies; (10) Dominion Lands Offices; (11) known outcrops of tar sands; (12) coal seams.

Canada—Alberta. **Dept. of the Interior, Ottawa.**

Map of the Grande Prairie, Peace River, and Grouard Land Districts, Province of Alberta, showing number of quarter sections in each Township available for Homestead entry. Prepared in the Railway Lands Branch under the direction of F. C. C. Lynch, Superintendent. Scale 1 : 1,584,000 or 1 inch to 25 stat. miles. Size 17 by 14 inches. Corrected to 1 April 1916. Ottawa: Department of the Interior, 1916. *Presented by the Department of the Interior, Ottawa.*

Canada—British Columbia. **Dept. of Lands, B.C.**

Pre-Emptor's Map. Scale 1 : 190,080 or 1 inch to 3 stat. miles. Sheets: 3 A, Fort George, size 27 by 40 inches; 3 M, Prince Rupert, size 42 by 30 inches. Victoria: Department of Lands, 1916. *Presented by the Department of Lands, B.C.*

Canada—Quebec. **Ministère des Terres et Forêts, Quebec.**

Québec. Scale 1 : 1,267,200 or 1 inch to 20 miles. Two sheets, each 33 by 54 inches. Quebec : Ministère des Terres et Forêts, 1914.

A large map of Quebec in two sheets including the whole of Labrador, compiled from the latest information. Canals and railways are shown, as well as steamship lines, upon which are given in figures the distances between various ports. There is also a table of distances by rail between principal places. The map is drawn on a polyconic projection and printed in colours.

United States. **Evans.**

The Evans Map of about 1795 or 1796. Reduced Facsimile of MS. map of the Missouri River from St. Charles, Mo., near its mouth, to above the Mandan villages, in what is now North Dakota. Scale 1 : 3,670,000 or 1 inch to 59·3 stat. miles. Size 13 by 17 inches. From the *Geographical Review*, vol. 1, No. 5, 1916, Pl. 11. *Presented by the American Geographical Society of New York.*

A photographic facsimile of a map recently brought to light by Dr. H. M. Hamblin, who found it amongst some old accounts in the Office of Indian Affairs, Washington, D.C. The map is published in the *Geographical Review* for May last, accompanied by an interesting critical discussion on its origin and history by Annie Heloise Abel, PH.D.

According to the conclusions arrived at, there is reason to believe that it was drawn somewhat earlier than the Lewis and Clark Expedition of 1804–6, and it was probably the map which President Jefferson sent to Meriwether Lewis in a letter dated 13 January 1804. It, or the original of which it may be a copy, was presumably compiled in 1795 or 1796 by John Evans, a Welshman in the employ of the Missouri Company. The map appears to be a pen and ink sketch, and although fairly neat and containing a considerable amount of detail, shows clearly that the author was not an experienced draughtsman. The size of the original is about 37 by 29 inches, and is on the scale of 1 : 1,630,000.

United States. **U.S. Geological Survey.**

Geologic Atlas of the United States. Folios: 195, Belleville-Breeze, Illinois; 196, Philipsbury, Montana; 197, Columbus, Ohio; 198, Castle Rock, Colorado. Size 22 by 19 inches. Washington : Department of the Interior, U.S. Geological Survey, 1915. *Price 25 cents each folio. Presented by the U.S. Geological Survey.*

United States. **U.S. Geological Survey.**

Topographical Maps of the United States. Scale 1 : 24,000 (2·6 inches to 1 stat. mile), sheet : Manhattan and vicinity, Nev. Scale 1 : 30,000 (2·1 inches to 1 stat. mile), sheet : Ely, Nev. Scale 1 : 31,680 (2 inches to 1 stat. mile), sheet : Saxon, Cal. Scale 1 : 62,500 (1·01 inch to 1 state. mile), sheets : Aitkin, Min.; Albany, Oreg.; Avon, Ill.; Bachelor Valley, Cal.; Bellefontaine, Ohio; Blue Mesa, Wy.; Buch, Va.; Bucyrus, Ohio; Byron, Cal.; Cache Slough, Cal.; Cooperstown, Cal.; Cornettsville, Ky.; Dixon, Cal.; Eagle Rock, Va.; East Liberty, Ohio; Edgington, Ill.-Iowa; Freedom, Idaho-Wys.; Gouverneur, N.Y.; Grays Bend, Cal.; Hershey, Cal.; Kinston, N.C.; Kohala, Hawaii; Lake Bonaparte, N.Y.; Larue, Ohio; Maine Prairie, Cal.; Mare Island, Cal.; Marseilles, Ill.; Mission, Tex.; Montpellier, Cal.; Mount Gilead, Ohio; Murfreesboro, Tenn.; Neosho, Mo.; Paulsell, Cal.; Richwood, Ohio; St. Albans, Vt.; San Juan, Tex.; Shauck, Ohio; Siam, Ohio; Soledad, Cal.; Three Tree Flat, Cal.; Tracy, Cal.; Waipio, Hawaii; Whitesburg, Ky.-Va.; Winona, W.Va; Wolf Point, Mont. Scale 1 : 125,000 (1 inch to 1·9 stat. miles), sheets : Deming, N. Mex.; Estacada, Oreg.; Pearce, Ariz. Scale 1 : 250,000 (1 inch to 3·9 stat. miles), sheet : Searles, Cal. Washington : Department of the Interior, U.S. Geological Survey, 1915–16. *Presented by the Director of the U.S. Geological Survey.*

World. **Clay, Greenwood, and Hattin.**

An Introductory Atlas of International Relations. By Henry Clay, M.A., and Arthur Greenwood, B.SC. Maps by H. S. Hattin. Size 10 by 8 inches. London : Headley Bros., 1916. *Price 1s. 6d. net. Presented by the Publishers.*

This atlas consists of forty-seven black and white sketch-maps, accompanied by seventy-four pages of text. The object is to illustrate international relations in the opening years of the twentieth century, and to supplement the ordinary school atlas of physical and political geography, in conjunction with which it is intended that the atlas should be used. Most of the maps are illustrative of the historical development of the European countries either directly or indirectly connected with the war, and their dependencies; but in addition there is a physical and ethnographical map of Europe, and maps of the Middle East, the China Seas, and the Panama Canal and Pacific Ocean. Each map

is dealt with separately in the text, which is decidedly instructive and interesting specially at the present time. The maps are all from line blocks, and many of them are too roughly produced to be of much use; for instance, the first map entitled "Europe Physical" is a hopeless muddle conveying nothing definite to the mind of a student.

PHOTOGRAPHS.

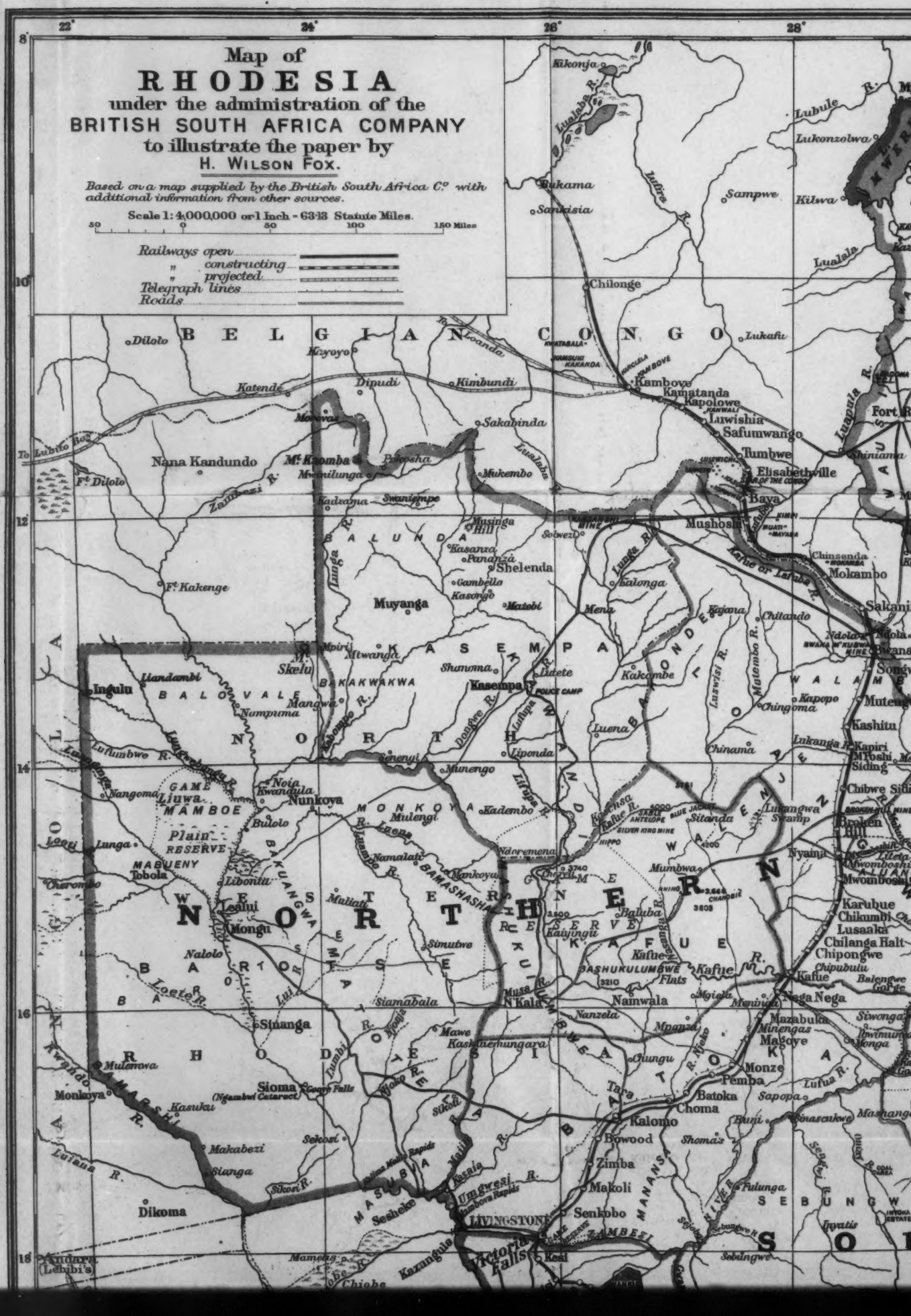
World. **Scott.**

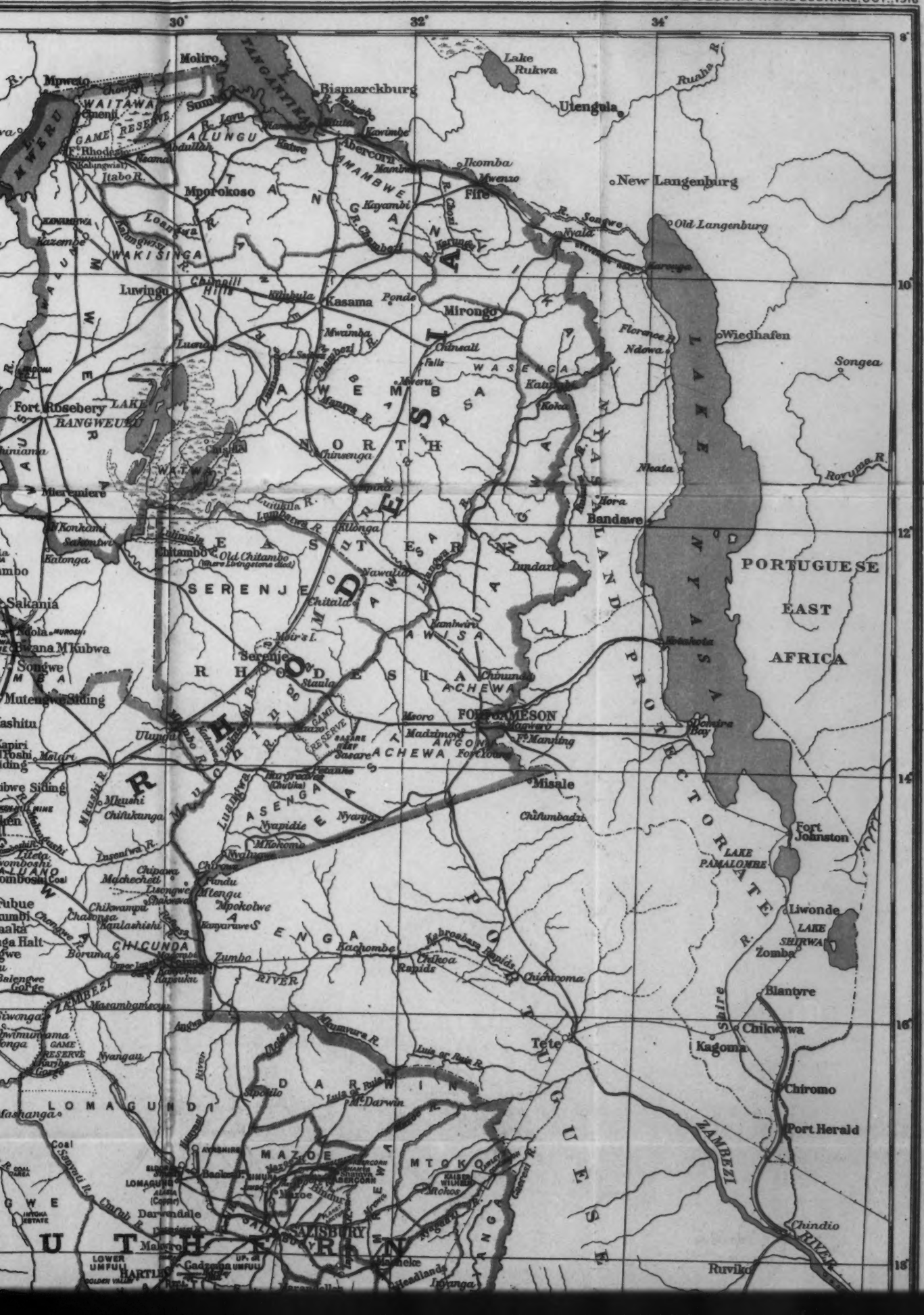
Eighty-six photographs of different parts of the world, taken by Lieut. H. K. Scott. 1904–16. *Presented by H. K. Scott.*

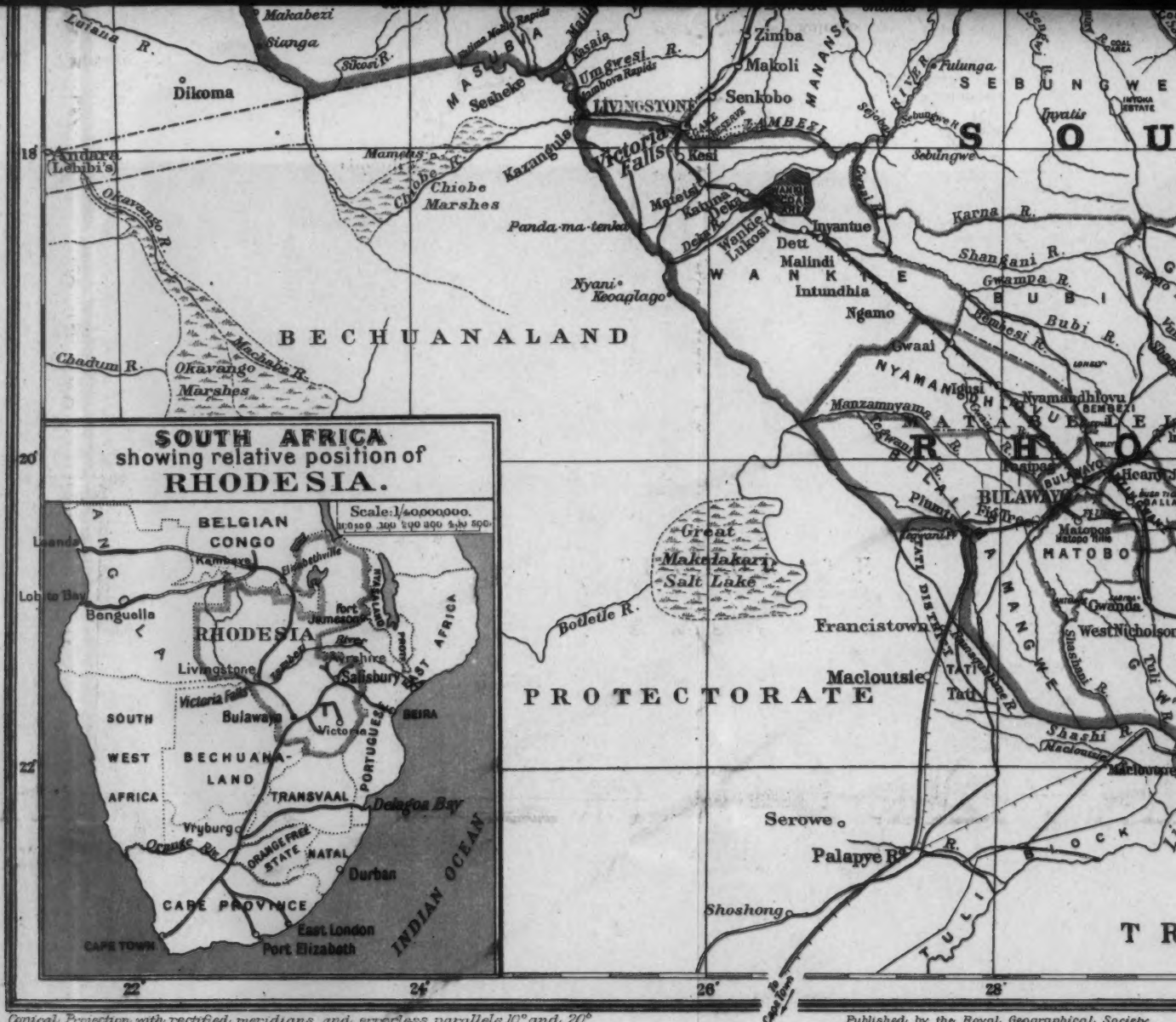
As will be seen from the titles, these photographs were taken in widely separated regions. They are all interesting, but those of the countries immediately connected with the war are worthy of special attention. They vary in size from 3 × 4 to 3¼ × 5¼ inches.

Bulgaria: (1) Peasants threshing corn; (2) Town of Vratza, 40 miles north of Sofia, occupied by Rumanian Army in second Balkan War; (3) Market, Sofia; (4) Children and sheep; (5) Street scene, Vratza; (6) Peasant women at Tvarditza, one with distaff; (7) Aerial ropeway from Plakalnitza copper mine to Elisena smelting works in valley near Vratza. **Bukovina**: (8) The Bistritz River Valley with Dorna Vatra in distance. **South Russia and Caucasus**: (9) British cemetery at Sebastopol; (10) Church at Ekaterinoslav; (11) Turkish women at Baku; (12) Filling an oil tank steamer at Batum; (13) Loading liquorice bales at Batum; (14) General Kuropatkin on board Black Sea steamer—taken the year before the Russo-Japanese War; (15) Georgian peasants threshing corn; (16) Itinerant musician, Caucasus; (17) Socchi, a Black Sea health resort; (18) Market at Chiaturi; (19) Kvirila River, in manganese ore district; (20) Kvirila River; (21) Kvirila River, near Chiaturi (buffaloes in water); (22) Manganese ore mines, Chiaturi, where 50 per cent. of the world's consumption is mined; (23) Hand-dressing manganese ore; (24) Unloading manganese ore from railway waggons at shipping port of Poti; (25) Stacking manganese ore at Poti. **Native Garhwal, North India**: (26) Native priest journeying to Baiyanath, one of the sources of the Ganges; (27) Priest reading to villagers; (28) Children transplanting rice; (29 and 30) School children; (31) General supply store; (32) Picking tea; (33) Scenery of lower Himalayas; (34) Sheep used for transport on roads between Native Garhwal and Tibet; (35) Working to the music of the tom-tom; (36) Workmen at the Dewangur copper deposit. **India, mostly Central Provinces**: (37 and 38) Market scene near Nagpur, C.P.; (39) Irrigation, C.P.; (40) Native village, C.P.; (41) At the well; (42) Bullock transport; (43) A live scarecrow; (44) A sacred place; (45) River and cattle, C.P.; (46) Zoological Gardens, Calcutta; (47) Two-handed shovelling (the man on the left swings the shovel with the rope); (48 and 49) Loading manganese ore into railway waggons; (50) One of the Gaekwar of Baroda's camels. **West Africa**: (51) Monrovia, capital of Liberia; (52) Off Monrovia, capital, Republic of Liberia; (53) Government Hill, Tarkwa; (54) Woman and child, Tarkwa; (55) Hen-coops made from paraffin tins; (56) Native dwellings near Tarkwa; (57) Group of natives, Tarkwa; (58) Market at Sekondi; (59) Fort at Sekondi. **Zululand**: (60) Zulus and kraal. **Suez Canal**: (61) A ferry; (62) A dhow; (63) A caravan; (64) Stone facing the canal sides. **Newfoundland and Nova Scotia**: (65) The *Mongolian* in the ice off St. John, Newfoundland, 1 June 1907; (66) Village on Bell Island, Conception Bay, Newfoundland; (67) Bell Island, north side, showing the iron-ore bed—one of the largest in the world—dipping under the sea; (68) Portugal Cove, near St. John, Newfoundland (a centre for cod curing); (69) Nova Scotian scenery. **Brazil**: (70) Rio Bay, with Brazilian Dreadnought in foreground; (71) Rio Bay and Sugar Loaf Mountain; (72) Fort at entrance to Rio Bay; (73) Serra do Curral, made up of high-grade iron ore, near Bello Horizonte, capital of the State of Minas Geraes; (74) Highlands of the State of Minas Geraes, with Serra do Piedade in distance; (75) Travelling in Minas Geraes; (76) Ouro Preto, late capital of Minas Geraes; (77) Old stone fountain, Ouro Preto; (78) Loading up pack-mules; (79) Mule carrying firewood; (80) A rough road near Ouro Preto; (81) Iron ore deposit near Bello Horizonte; (82) Ferruginous iron schist, Serra do Piedade; (83) Market, city of Bahia; (84) Fruitseller, city of Bahia; (85) Boatman, city of Bahia; (86) Old negro, city of Bahia.

N.B.—It would greatly add to the value of the collection of Photographs which have been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.


Map of
RHODESIA
under the administration of the
BRITISH SOUTH AFRICA COMPANY
to illustrate the paper by
H. WILSON FOX.
Based on a map supplied by the British South Africa Co. with additional information from other sources.
Scale 1:4,000,000 or 1 Inch = 63·13 Statute Miles.
50 0 50 100 150 Miles
Railways open
" constructing
" projected
Telegraph lines
Roads
22° 24° 26° 28°
8° 10° 12° 14° 16° 18°
BELGIAN CONGO
NORTH WESTERN RHODESIA
NORTH EASTERN RHODESIA
BECHUANALAND
Kikonja
Lualaba R.
Lubule R.
Lukonzolwa
Rukama
Sampwe
Kilwa
Santasia
Luapula R.
Lualala
Chilonge
Dilolo
Kayoyo
Katende
Dipudi
Kimbundi
Kambove
Kamatanda
Kapolowe
Luwishia
Safumwango
Lukafu
Lufira R.
Luapula R.
Fort Rosebery
Moreva
Sakabinda
Tumbwe
Shiniama
To Lubito Bay
Nana Kandundo
Mt. Kaomba
Mwenilunga
Pelposha
Mukembo
Elisabethville
Ft. Dilolo
Zambezi R.
Kadzana
Swaniempe
Baya
Mushoshi
Musinga Hill
Kasanza
Panonza
Shelenda
Solwezi
Chinsenda
Mokambo
Ft. Kakenge
Gambella
Kasongo
Matobi
Muyanga
Mena
Kalonga
Sakania
Kafue or Lufube R.
Kajana
Chitando
Ndola
Mpiri
Mwanga
Skelu
Shamona
Kasempa
Lidete
Kakombe
Kapopo
Mutendere
Ingulu
Liandambi
Mangwa
Numpuma
Kashitu
Lufumbwe R.
Senengi
Liponda
Chinama
Kapiri Mposhi Siding
Nangoma
Noia
Kwandula
Nunkoya
Munengo
Kadembo
Sitanda
Chibwe Siding
Liuwa
Mulengi
Lunga R.
Broken Hill
Loeti
Lunga
Plain
Bulolo
Ndoremena
Nyama
Tobola
Libonta
Mankoya
Mumbwa
Mwomboshi
Mwomboshi R.
Karubue
Chikumbi
Lealui
Mongu
Baluba R.
Lusaaka
Nalolo
Simutwe
Kafue R.
Chilanga Halt
Chipongwe
Loeti R.
Siamabala
N'Kala
Namwala
Nega Nega
Sinanga
Nanzela
Mazabuka
Mawe
Kashitaehungara
Mpanza
Minengas
Malaye
Mulenowa
Chungu
Monze
Sioma
Ngambwi Cataract
Tara
Batoka
Pemba
Lufua R.
Monkoya
Kasuka
Choma
Kalomo
Bowood
Sapopa
Makabezi
Sekosi
Zimba
Sianga
Makoli
Fulunga
Dikoma
Senkobo
LIVINGSTONE
Victoria Falls
Kazungula
Kesi
Sebungwe
Lehibis
Mamess
Chioba
Lake Ngami
Kwando R.
Zambezi R.
Luiana R.
Sikosi R.
Sesheke
Kasaia
Umgwesi R.
Kalomo R.
Kafue R.
Mumbwa
Broken Hill
Chilanga Halt
Chipongwe
Kafue
Choma
Kalomo
Monze
Pemba
Batoka
Livingstone
Victoria Falls
Zambezi R.


30°
32°
34°
8°
10°
12°
14°
16°
18°
Moliro
Mpweto
Bismarckburg
Lake Rukwa
Ruaha R.
Utenguia
WAITAWA GAME RESERVE
ALUNGU
Abercorn
Kawimbe
Ikomba
Mweuzo
New Langenburg
Itabo R.
Mporokoso
Fife
Kayambi
Old Langenburg
Songwe R.
Nyalz
WAKISINGA
Luwingu
Kasama
Ponde
Mirongo
Wiedhafen
Songea
Fort Rosebery
LAKE RANGWEULU
Mwamba R.
Chinsali
WASENGA
Kate
Koka
Meata
Rovuma R.
Mweru
Chinsenga
Mpika
Bandawe
Mlanje
Lumbatwa R.
Kilonga
Old Chitambo
Chitambo
Lundazi
PORTUGUESE EAST AFRICA
SERENJE
Chitala
Sakania
Ndola
Kambwiri
AWISA
Kasakota
Serenje
Mutenguwe Siding
Chinunda
ACHEWA
FORT JAMESON
Mporo
Madzimoss
Ft. Manning
Monzire Bay
Ulungu
Sasare
Misale
Chitukunga
Nyapidie
Chitumbadzi
Fort Johnston
LAKE PAMALOMBE
Mchekeli
Chiwampa
Chikwampa
Mpakolwe
Kazyaruwe
Liwonde
LAKE SHIRWA
Zomba
CHICUNDA
Zumba
Kachombe
Chikoa Rapids
Chichicoma
Blantyre
RIVER
Masambamoyo
Tete
Chikwawa
Kagoma
Nyangau
Luis or Rois R.
Spolilo
Mt. Darwin
Chiromo
LOMAGUNDI
Port Herald
ZAMBEZI
Coal
AVONDALE
MAZOE
Darwendale
Chindio
SALISBURY
Ruvika
Gadzema
Mashoko
Headlands
Inyanga
UMTALI
LOWER UMFULI
HARTLEY
Golden Valley
Mtoko
Kaisi Wilmer
Beacon
Hindura
Lo
Mazoe
Lomagundi (Copper)
Inyoka Estate
Coal Area
Sanyati R.
Umfuli R.
Darwin R.
Mazoe R.
Mtoko R.
Angwa R.
Luangwa R.
Zambezi R.
Shire R.
Ruo R.
Pungwe R.
Lake Nyasa
Nyasaland Protectorate
Portuguese
Rhodesia
Northern
Eastern
Central
Southern
Western
Tangantika
Rhodesia
Nyasaland
Protectorate
Portuguese East Africa



Conical Projection with rectified meridians and errorless parallels 10° and 20°

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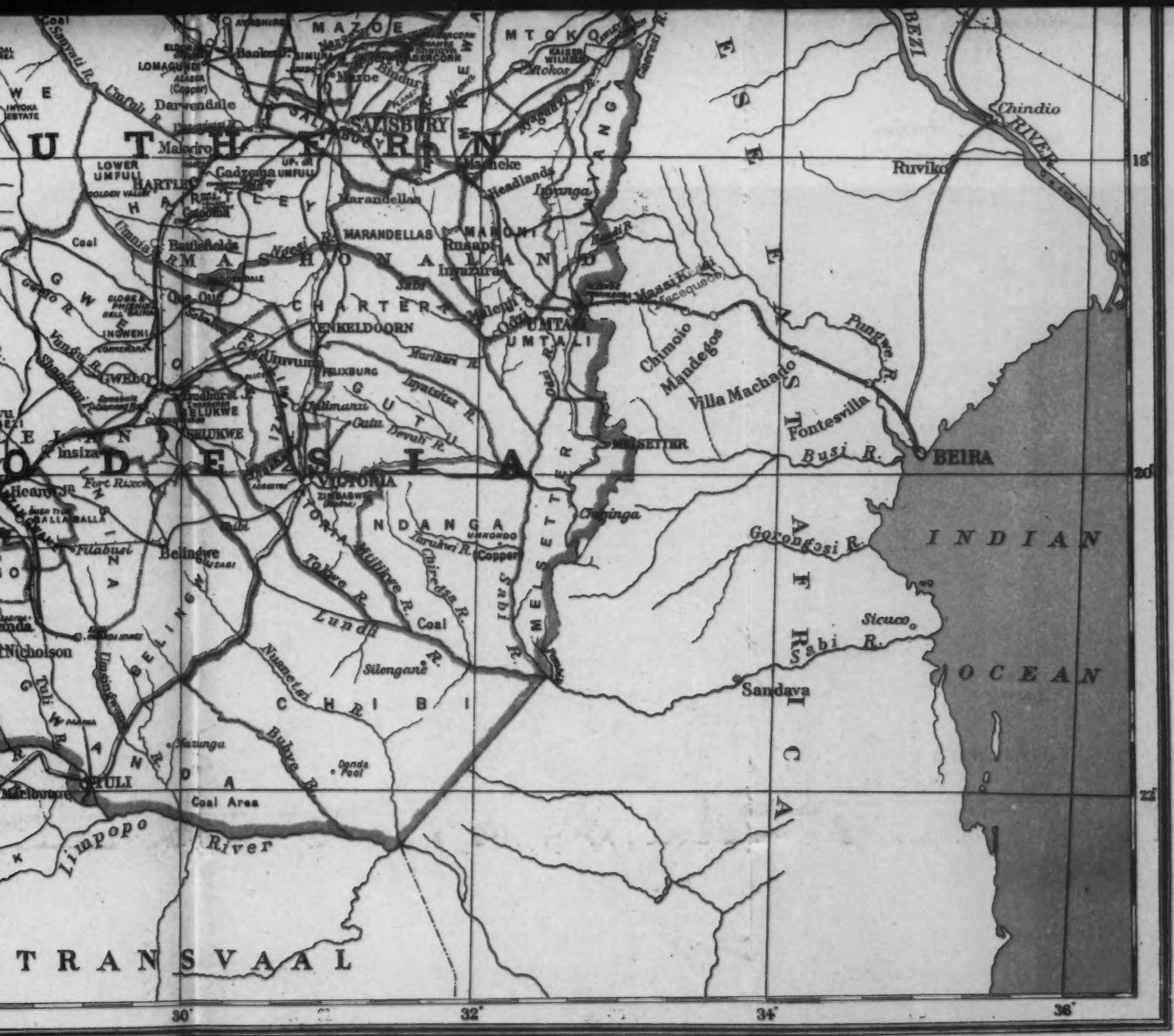
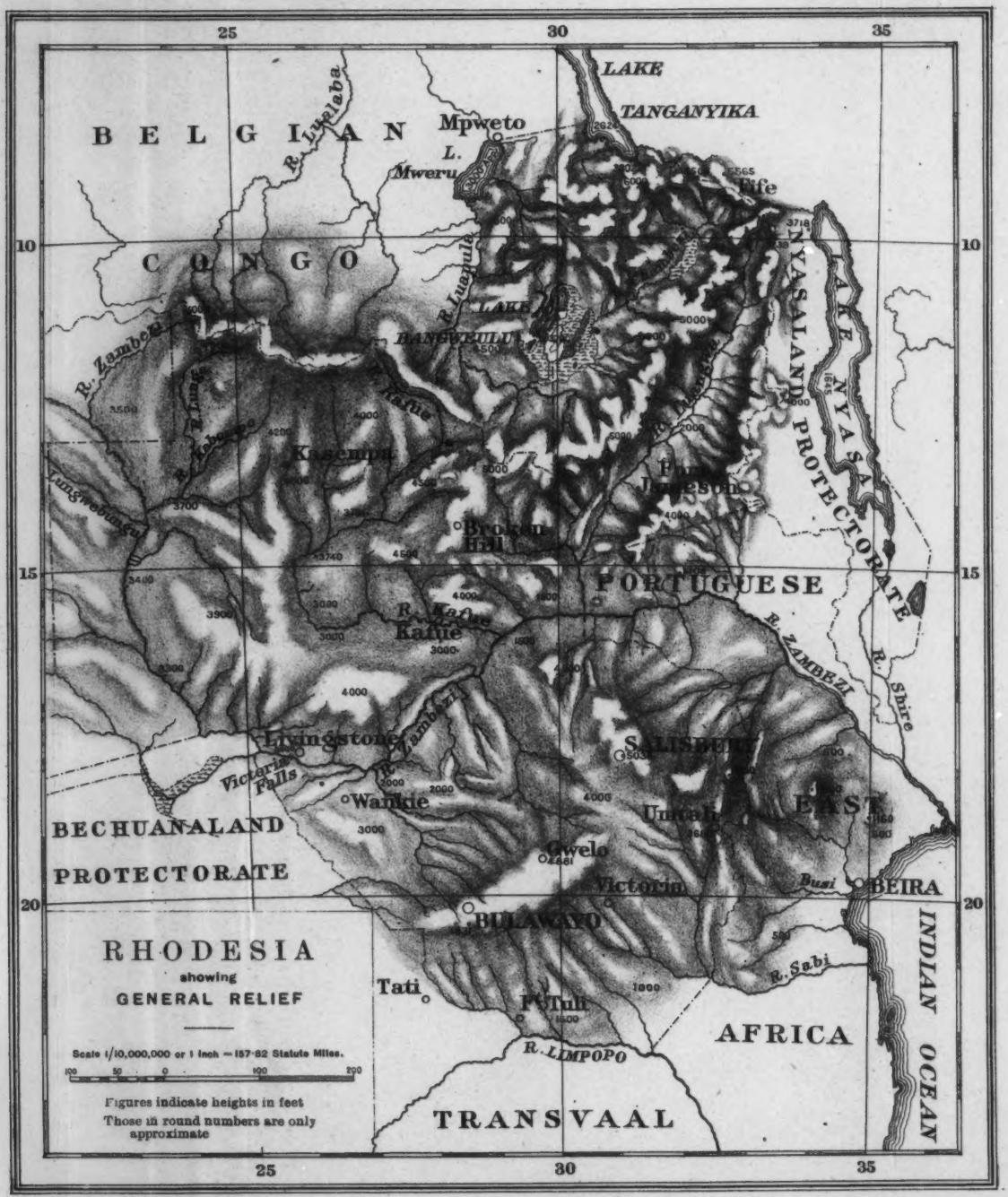


Society.

RHODESIA.

WILSON FOX.



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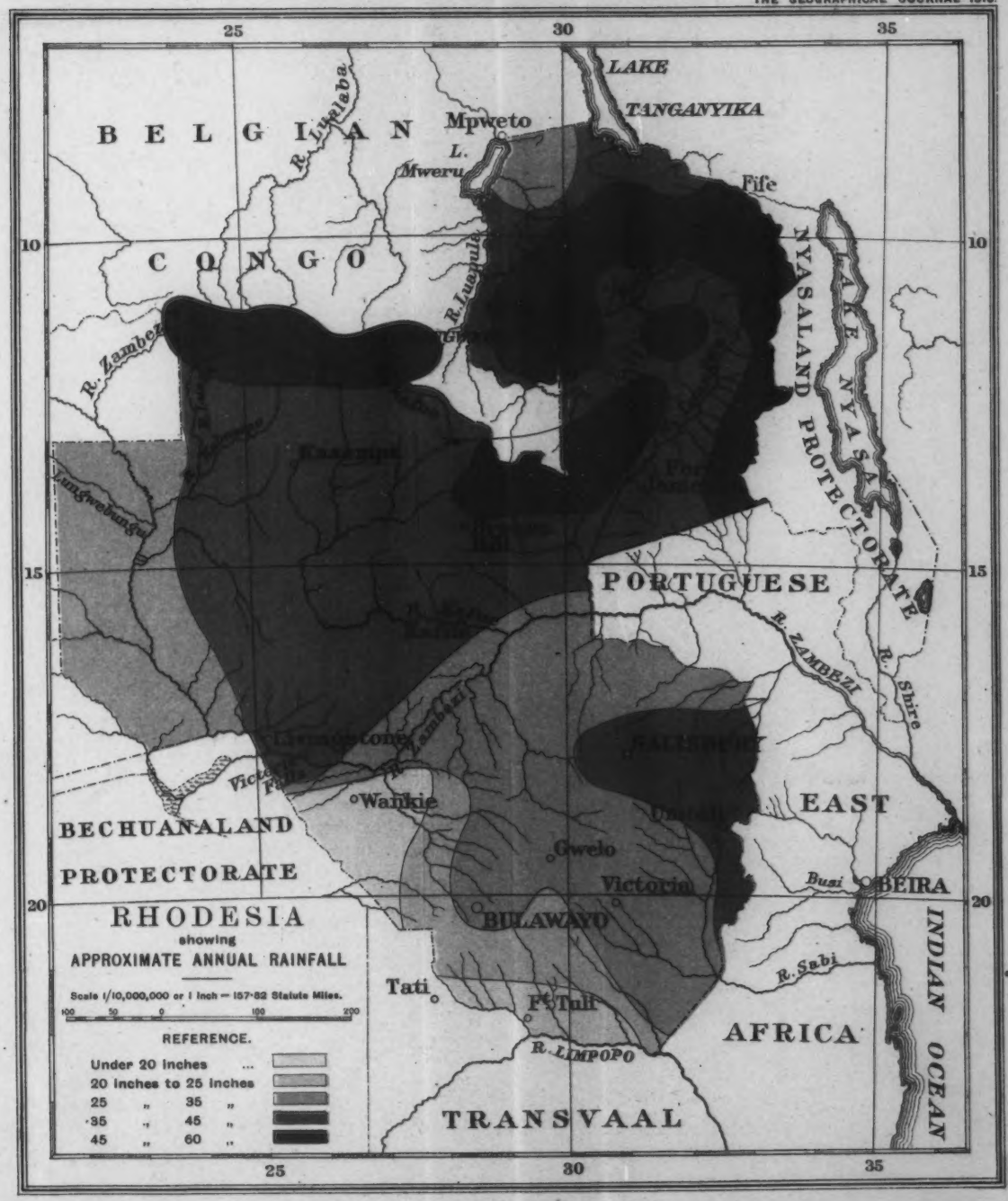

RHODESIA.
Wilson Fox.

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